PROCEEDINGS *of the* HAWAIIAN ENTOMOLOGICAL SOCIETY *for* 1949

VOL. XIV, No. 1
MARCH, 1950

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MEMBERSHIP 1949

Alicata, J. E.
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Balock, J. W.
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Bianchi, F. A.
Blalock, J. R.
Bonnet, D. D.
Bryan, E. H., Jr.
Callan, E. McC.
Carpenter, G. D. H.
Carter, Walter
Chilson, L. M.
Chong, Mabel
Clancy, D. W.
Davis, C. J.
Doutt, R. L.
Faxon, Richard
Finney, G. L.
Flitters, N. E.
French, E. W.
Haramoto, F. H.
Hardy, D. Elmo
Hinman, F. G.
Holdaway, F. G.
Hu, Stephen M. K.
Illingworth, J. F.
Inada, Constance
Ito, K.
Jensen, D. D.
Joyce, C. R.
Keck, C. B.
Krauss, N. L. H.
Kumabe, Bunki
Lewis, J. Guy
Look, Wm. C.
McBride, O. C.
Maehler, K. L.
Mainland, G. B.
Marlowe, R. H.
Marucci, P. E.
Matsuura, M.
Mumford, E. P.
Newell, I. M.
Nihei, C. T.
Nishida, Takiyuki
Nowell, W. R.
Owen, R. P.
Pelot, Betty Lou
Pemberton, C. E.
Peterson, G. D., Jr.
Ritchie, C. L.
Rosa, J. S.
Ross, Marshall
Sakimura, K.
Schmidt, C. T.
Schwabe, C. W.
Sherman, John D.
Sherman, Martin
Smith, Gordon L.
Steiner, L. F.
Stone, W. E.
Stout, O. O.
Suehiro, Amy
Tanada, Yoshinori
Thomsen, Walter
Timberlake, P. H.
Tuthill, L. D.
Usinger, R. L.
van den Bosch, Robert
Van Zwaluwenburg, R. H.
Waters, N. D.
Weber, P. W.
Wirth, W. W.
Wolfenbarger, D. O.
Zimmerman, E. C.

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MEMBERSHIP 1949

Allison, J. F.
Au, Stephen
Balock, J. W.
Bas, Henry A.
Bianchi, F. A.
Bisbecki, J. R.
Bonner, D. D.
Bryan, E. H., Jr.
Collier, E. McC.
Carpenter, G. D. H.
Carter, Walter
Chilson, J. M.
Clung, Mabel
Clancy, D. W.
Davis, C. J.
Doutt, R. L.
Faxon, Richard
Finley, G. L.
Flitters, N. E.
French, F. W.
Haramoto, F. H.
Hardy, D. Elmo
Hinman, F. G.
Holtaway, F. G.
Ho, Stephen M. R.
Illingworth, J. F.
Inada, Constance
Ito, K.
Jessup, D. D.
Joyce, C. R.
Kock, C. R.
Kyuma, N. L. H.
Kunabe, Ronki
Lewis, J. Guy
Look, Wm. C.
McBride, O. C.
Marbler, K. L.
Mainland, G. B.
Mariowe, R. H.
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Ritchie, C. L.
Ross, J. S.
Ross, Marshall
Sakimura, K.
Scanidt, C. T.
Schwabe, C. W.
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Wirth, W. W.
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Zimmerman, E. C.

PROCEEDINGS
OF THE
Hawaiian Entomological Society

VOL. XIV, No. 1 FOR THE YEAR 1949 MARCH, 1950

JANUARY 10, 1949

The 517th meeting was held at the H.S.P.A. Experiment Station on Monday, January 10, at 2:00 p.m., with President Balock in the chair.

Members present: Alicata, Balock, Bianchi, Flitters, Hardy, Hinman, Inada, Joyce, Keck, Mainland, Nishida, Pelot, Pemberton, Rosa, Sakimura, Schwabe, Swezey, Tanada, Tuthill, Van Zwaluwenburg and Zimmerman.

Visitors: I. M. Newell and Walter Thomsen.

Dr. I. M. Newell was nominated for membership.

PAPER

Dr. Swezey presented his paper: "Morganella longispina (Morgan) on Avocado in Hawaii (Homoptera: Diaspididae)."

NOTES AND EXHIBITIONS

VANDUZEA SEGMENTATA (Fowler)—Mr. Pemberton reported finding, on January 9, large numbers of this membracid in all stages on *Erigeron canadensis* and on *Casuarina equisetifolia*, at Kawela, Oahu. It was definitely breeding on both plants, and in both cases was heavily attended by the ant, *Pheidole megacephala* (F.).

GRAPHOMYA MACULATA (Scopoli)—Mr. Joyce reported capturing three females of this muscid fly, hovering around blossoms of *Pluchea indica* near Moanalua Gardens, on January 6. This indicates that this fly is now well established on Oahu. The only previously recorded capture was of a single male at Ft. Armstrong, Honolulu, in March 1948; at the time it was thought the fly might have come from a ship in harbor.

CHRYSOPA MICROPHYA McLachlan—Dr. Tuthill told of rearing this chrysopid last August from a larva feeding on nymphs of the psyllid, *Hevaheva* sp., taken at Kuliouou, Oahu. Like other chrysopids, the insect piled the nymphal remains of its victims on its back.

DACUS DORSALIS Hendel—Mr. Nishida reported rearing this fruit fly in considerable numbers from tomatoes. Occasional specimens have been reported from tomatoes in the past, but Mr. Nishida now gets as many *dorsalis* as *D. cucurbitae* Coquillett from some lots of tomatoes. Mr. Pemberton said that last October he reared 25 *cucurbitae* and 10 *dorsalis* from 11 tomatoes.

TRICHINELLA SPIRALIS Owen—Dr. Alicata gave a preliminary report on the effects of radiation with an isotope of cobalt on trichina in muscle fiber of experimental animals. Comparatively low radiation for rather short periods of time resulted in sterilization of the reproductive cells of the parasitic worm. The work was done in cooperation with Dr. George O. Burr of the H.S.P.A. Experiment Station. [For a detailed account of these experiments see "Science," 109:595-596, June 10, 1949.]

FEBRUARY 14, 1949

The 518th meeting was held at the H.S.P.A. Experiment Station on Monday, February 14, at 2:00 p.m., with President Balock in the chair.

Members present: Alicata, Balock, Bess, Bonnet, Bryan, Hinman, Inada, Ito, Look, Mainland, Newell, Pelot, Rosa, Sakimura, Tanada, Tuthill, Van Zwaluwenburg and Zimmerman.

Visitor: John R. Blalock.

Dr. I. M. Newell was elected a member of the Society, and J. R. Blalock was nominated for corresponding membership.

NOTES AND EXHIBITIONS

DACUS DORSALIS Hendel—Mr. Look reported the coco plum (*Chrysobalanus icaco*) as a new field host of the oriental fruit fly. Three fruits collected in Manoa Valley in December by Mr. McGuire of the Board of Agriculture and Forestry, yielded 16 *dorsalis* adults.

Dr. Bess reported that, following a call from a nurseryman in Manoa Valley, he and Mr. Nishida found dozens of *Vanda* blossoms and buds in the field with oviposition punctures, as well as eggs and first instar larvae of what appeared to be *Dacus dorsalis*. From about 15 flowers and buds Miss Pelot obtained 27 eggs and five larvae, all of which she transferred to papaya. Subsequently four of the larvae pupated on February 21, and four adult *dorsalis* flies emerged on March 7; none of the eggs hatched.

PSYCHODID AT LIGHTS—Dr. Tuthill reported great numbers of a psychodid fly (either *Psychoda alternata* Say or *P. pseudoalternata* Tonnoir) attracted to lights on the University campus.

EUPHRANTA LEMNISCATA (Enderlein)—Dr. Bess reported that Dr. Hardy had determined as this tephritid species, two females and a male taken by Mr. Maehler at Kobler Field, Saipan, on January 13, 1949. This is the first record of its occurrence in the Marianas; the fly was described from Formosa.

EUMENES LATREILLEI PETIOLARIS (Schulz)—Dr. Henry Townes in a recent letter said that he had seen, in a Washington collection, a female of this wasp obtained through Dr. Sam Munson, collected in Honolulu, August 6, 1944. This antedates by two years the earliest previous capture of this species in Hawaii by Dr. Townes in September 1946 (Proc. Haw. Ent. Soc., 12:105, 1947).

MARCH 14, 1949

The 519th meeting was held at the H.S.P.A. Experiment Station on Monday, March 14, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Bess, Bonnet, Bryan, Chong, Clancy, Hardy, Hinman, Hu, Inada, Joyce, Look, Newell, Nishida, Pelot, Pemberton, Rosa, Sakimura, Schmidt, Schwabe, Stout, Swezey, Tanada, Tuthill, Van Zwaluwenburg, Weber and Zimmerman.

Visitors: R. P. Owen and A. B. Weir.

John R. Blalock was elected a corresponding member and R. P. Owen was nominated for membership.

PAPER

Dr. Swezey presented his paper: "Notes on the Life Cycle of Certain Introduced Cerambycid Beetles."

NOTES AND EXHIBITIONS

MUSCA SORBENS Wiedemann—Mr. Joyce exhibited a specimen of this muscid taken at Waianae, Oahu, September 18, 1949, apparently a recent immigrant to the Islands. Other specimens were seen, but not captured at Hanauma Bay, Oahu. Identity of the fly was confirmed by C. W. Sabrosky. Though not previously known in Hawaii, this fly was frequently intercepted on planes during the war, according to Mr. Pemberton.

M. sorbens is a common household pest in the tropics and subtropics, from the Mediterranean basin eastward throughout southern Asia. It breeds in a variety of situations similar to those in which *Musca domestica* L. breeds: cowdung and human excreta. It is somewhat smaller than the house fly and can be distinguished by the two black vittae on the mesonotum. In the female these vittae are divided in the form of a Y in front of the suture.

COMPERIELLA BIFASCIATA Howard—Dr. Swezey exhibited a slide mount of a female of this encyrtid, reared from the scale, *Morganella longispina* (Morgan), on avocado leaves in Honolulu, January 20. It is a striking species distinguished by two conspicuous longitudinal dark fasciae on the apical half of the forewing of the female. The female is figured by Compere (Univ. Calif. Ent. Publ., 4:46, 1926). The male is quite different, with the wings clear and not fasciated. *C. bifasciata* has been reared in Hawaii from *Aspidiotus* sp., *Hemiberlesia rapax* (Comstock), *Chrysomphalus ficus* Ashmead and *Saissetia hemispherica* (Targ.-Tozz.). This is the first record from *M. longispina*, and the fourth parasite from this host in Hawaii, the others being: *Prospaltella koebelei* Howard, *Archenomus perkinsi* (Fullaway) and *Aphytis chrysomphali* (Mercet).

STICTOPTERA SUBOBLIQUA (Walker)—Dr. Swezey remarked on the work of caterpillars of this recent immigrant agrotid moth on *Calophyllum inophyllum* on the University campus. The tender new leaves were all

much eaten and in ragged condition; only a single caterpillar could be found.

Mr. Van Zwaluwenburg remarked on finding larvae of this moth on *Calophyllum* on Molokai on February 16, a new island record. The species almost certainly occurs also on Maui and Hawaii, where its characteristic damage is common, although no caterpillars have been found.

EUMENES NEST—Dr. Swezey reported seeing an unusually large mud nest of one of the new immigrant *Eumenes* wasps, either *latreillei petiolaris* (Schulz) or *pyriformis* Bequaert. It consisted of 25 cells in a horizontal line; heretofore all the nests he had observed have had the row of cells vertical.

ENCEPHALITIS ON GUAM—Dr. Hu said that Dr. W. McD. Hammon of the Hooper Foundation recently reported that Type B encephalitis, a form of sleeping sickness with high case fatality, has been found on Guam. Two of the mosquitoes in Hawaii, *Culex quinquefasciatus* Say and *Aedes albopictus* (Skuse), are possible carriers of this virus, as they were found experimentally to be susceptible to infection. Referring to the anopheline recently found established on Guam, *Anopheles subpictus* Grassi, Dr. Hu said that under favorable conditions it is an extremely rapid breeder. Dr. Bonnet added that it is rarely collected on humans, but can be caught in numbers in a horse-baited trap.

PSEUDOCOCCUS ADONIDUM (L.)—Mr. Van Zwaluwenburg reported a previously unrecorded hostplant of the long-tailed mealybug. Foliage of the so-called Galphimia vine (*Tristellateia australasica*) from Kahala was infested by it. Several of the mealybugs were parasitized by the encyrtid, *Bothriencyrtus insularis* (Cameron) (det. by C. E. Pemberton), a parasite previously recorded apparently, only from *Ferrisiana virgata* (Cockerell), although Dr. Swezey reared it from *P. adonidum* (*"longispinus"*) in 1938.

MANSON'S EYEWORM—Mr. Schwabe said that he had found *Oxyspirura mansoni* (Cobbold), the common eyeworm in poultry, survived as infective larvae for at least 48 hours in the intermediate host, the burrowing roach, *Pycnoscelus surinamensis* (L.), after the host had been killed by a 2 per cent mixture of chlordane and sodium fluoride. This was the maximum period over which observations were made. The significance of this observation is that birds must not be allowed access to dead *Pycnoscelus* or they may contract eyeworm, even though the roaches may be subject to effective chemical control.

APRIL 11

The 520th meeting was held at the H.S.P.A. Experiment Station on Monday, April 11, at 2:00 p.m., with President Balock in the chair.

Members present: Alicata, Balock, Bess, Blalock, Bonnet, Carter, Chong, Clancy, French, Hardy, Hu, Inada, Joyce, Keck, Lewis, Look,

Mainland, Nishida, Pelot, Pemberton, Rosa, Sakimura, Schmidt, Schwabe, Stout, Swezey, Tanada, Tuthill, Van Zwaluwenburg and Weber.

Visitors: A. C. Baker, J. C. Bequaert, P. E. Marucci, H. I. Rainwater, Harry S. Smith, W. E. van Steenburgh, Donald Weedmark and A. B. Weir.

R. P. Owen was elected a member of the Society, and Philip E. Marucci and Wesley R. Nowell were nominated for membership.

PAPERS

The following papers were presented: "The Biology of the Mariana Coconut Beetle, Brontispa mariana Spaeth, on Saipan, and the Introduction of Parasites from Malaya and Java," by W. Harry Lange, Jr.; "Field Studies on the Parasites of Brontispa mariana Spaeth," by Richard L. Doutt; and "Homoneura vs. Sciomyza in Hawaii (Diptera)," by D. Elmo Hardy.

NOTES AND EXHIBITIONS

TRICHOPHAGA TAPETZELLA (L.)—Dr. Swezey reported that specimens of this tineid moth were obtained from a pelt received from Sweden. The insect has been known here for several years, having been bred from rabbit skins in 1944, and in 1945 taken in light traps.

CALLIPHORA VICINA (Robineau-Desvoidy)—The presence of this European bluebottle fly was reported in Hawaii for the first time by Mr. Joyce. One specimen was taken in a mosquito light trap at the Public Health Service quarantine station in Honolulu, June 11, 1947, and another in a fly trap on September 30, 1948. Possibly specimens will be found in collections made prior to the above dates, since there has been considerable confusion in literature concerning the differentiation of *C. vicina* and *C. vomitoria* L. The latter has been reported here a number of times.

In *C. vicina* the bucca is reddish on the anterior half or more, and the basicosta is yellow to yellow-orange; in *vomatoria* the bucca is black, and the basicosta and the hairs on the posterior part of the bucca, orange. Adults of *C. vicina* occur commonly in houses during the cooler seasons in temperate regions. The normal breeding medium is carrion, although the eggs are occasionally found on tainted meat. Though uncommon, the maggots have been known to cause severe myiasis in man by entering diseased tissue. The species is widespread throughout the temperate parts of the world.

PALMYRA ISLAND MOSQUITOES—Dr. Hu reported that a mosquito survey of Palmyra Island, made April 4-7, shows the only species present to be *Culex quinquefasciatus* Say. The larvae were found in rainwater in coconut shells, as well as in artificial containers. Before the war the island was free of mosquitoes.

ENEMIES OF ACHATINA—Dr. Joseph C. Bequaert of the Museum of Comparative Zoology at Harvard University, presented some notes, based on observations by Dr. F. X. Williams, on the enemies of the giant

African snail in its East African home. These are summarized as follows: The most efficient enemies appear to be other carnivorous snails of the family Streptaxidae. Two of the larger species were exhibited, *Edentulina affinis* C. R. Boettger, and *Gonaxis kibweziensis* E. A. Smith. Both of these were brought alive to Honolulu by Dr. Williams about a year ago, and kept in quarantine, a few specimens surviving to the present day, being fed on local *Achatina fulica* Férrusac. Several East African beetles are also voracious and exclusive snail-eaters, either as adults (Carabidae of the genus *Tefflus,* etc.), or as larvae (Drilidae and Lampyridae). The larva and the wingless adult female of one of the drilids were shown. Although the foregoing predators are strictly snail-eating, none are specific to *Achatina;* all will attack any type of snail or slug of suitable size. Their release has not been authorized thus far.

MAY 9

The 521st meeting was held at the H.S.P.A. Experiment Station on Monday, May 9, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Bess, Blalock, Bonnet, Clancy, Hardy, Hinman, Hu, Inada, Ito, Keck, Look, Mainland, Marucci, Nishida, Pelot, Pemberton, Ritchie, Rosa, Sakimura, Stout, Schwabe, Swezey, Tanada, Tuthill and Van Zwaluwenburg.

Visitors: A. C. Baker, C. E. Cooley and Walter Thomsen.

Philip E. Marucci and Wesley R. Nowell were elected to the Society.

PAPER

A paper by Pierre E. L. Viette was presented: "Contribution to the Study of the Hepialidae (9th Note): The Genus Phassodes Bethune-Baker (Lepidoptera)."

NOTES AND EXHIBITIONS

LASIODERMA SERRICORNE (F.)—Dr. Hardy exhibited a woolen cap infested and damaged by this anobiid, the cigarette beetle. The beetles were working in the vizor; within, this consisted of a sack-cloth material stiffened with a hard, glue-like substance. Both adults and larvae were tunnelling through the stiffening substance between the fibers of the cloth. There was no evidence of feeding on the wool itself.

SCHOLASTES PALMYRA Curran—Dr. Hardy exhibited specimens of this platystomatid fly collected April 6, 1949, on Palmyra Island by Dr. Hu. The species is closely allied to *S. lonchifera* Hendel, described from the Cook Islands and reported throughout the Society group.

PLATYPTILIA CARDUIDACTYLA (Riley)—Dr. Swezey exhibited a caterpillar of this pterophorid moth, found by Mrs. Swezey in an artichoke from California. There was no external evidence of injury, and only two or three of the innermost bracts were injured, where the larva must have worked its way down from the small egg laid at the apex; the larva was active and in good condition.

CARPOPHILUS IN MACADAMIA NUT—Dr. Swezey exhibited a larva of *Carpophilus* sp. found in a macadamia nut. Several nuts were found with a hole at the stem end. In one of these the entire kernel had been eaten, and there were several dead nitidulid larvae amid the refuse; only one was alive. *C. maculatus* Murray was once recorded similarly from macadamia.

ANTONINA GRAMINIS (Maskell)—Dr. Clancy reported the following: This common grass-infesting scale has been known here since 1910 and appears to be effectively controlled by the encyrtid, *Anagyrus antoninae* Timberlake. Occasional outbreaks on lawns are usually of brief duration. The scale has recently become a serious pest of various range grasses in southern Texas, and on March 4 and April 23, shipments of the *Anagyrus* parasite were sent from Hawaii to P. T. Riherd of the Weslaco, Texas, substation, through the U. S. Bureau of Entomology's Division of Foreign Parasite Introduction. C. P. Clausen recently reported that production of Rhodes grass on the King ranch was substantially reduced; an area of about 50,000 acres would, at the present time, yield an aggregate of not more than one acre of good hay. All of this loss was attributed to the scale insect.

EUCELATORIA ARMIGERA (Coquillett)—Mr. Van Zwaluwenburg reported that Mr. Keck had brought in caterpillars of the coconut leafroller, *Omiodes blackburni* (Butler), parasitized by this tachinid. Adult flies found dead in the web were in poor condition, but examination of empty puparia established the fact that they were *Eucelatoria*. *O. blackburni* thus becomes the eighth lepidopterous host of this tachinid to be reported locally.

OECHALIA PACIFICA (Stål)—Mr. Van Zwaluwenburg also reported that Mr. Keck had found an adult of this pentatomid bug feeding on half-grown larvae of the geometrid moth, *Anacamptodes fragilaria* (Grossbeck).

JUNE 13

The 522nd meeting was held at the H.S.P.A. Experiment Station on Monday, June 13, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Bess, Carter, Clancy, Hardy, Hinman, Inada, Look, Maehler, Mainland, Marucci, Pelot, Rosa, Sakimura, Schmidt, Schwabe, Swezey, Tuthill and Van Zwaluwenburg.

Visitors: P. N. Annand, G. F. Ferris, F. D. Morrison, Newton Morton and Walter Thomsen.

Dr. R. L. Doutt was nominated for corresponding membership.

NOTES AND EXHIBITIONS

CRYPSITHYRIS PHERETROPA Meyrick—Dr. Swezey exhibited specimens of this immigrant tineid moth collected commonly at light traps in Manoa

Valley, Kaneohe, Wahiawa and the Pearl Harbor region of Oahu, from 1944-1946. The species was not previously known in Hawaii, but due to oversight has not before been recorded in these "Proceedings." It was described (Exotic Microlepidoptera, 4:105, 1931) from Assam, and is distinguished from other species of the genus by the thinly-scaled, longitudinal 8-shaped impression in the end of the cell of the male forewing. Another species, *C. enixa* Meyrick (Zool. Med. Leiden, 6:197, 1921) from Java, has been known here for some time, having been reared by Dr. Swezey from trash in axils of old leaves of date palm, in 1921. No doubt *C. pheretropa* has similar scavenger habits.

EUMENES LATREILLEI PETIOLARIS (Schulz)—Dr. Swezey told of having seen as many as a half a dozen of these wasps feeding at one time on flowers of *Justicia betonica.*

PINEAPPLE MEALYBUGS—Dr. Carter described some results following field treatments for mealybugs on pineapple. Field control of *Pseudococcus brevipes* (Cockerell) aims to eliminate *Pheidole* ants in the early months of the crop. In areas treated with DDT, *P. adonidum* (L.) (*P. longispinus* Targ.-Tozz.) entirely replaced *brevipes.* Applications of parathion controlled both species of mealybugs, but in the DDT areas *adonidum* was abundant, and attracted many *Cryptolaemus montrouzieri* Mulsant, which were apparently little affected by the DDT.

TACHYPOMPILUS ANALIS (F.)—A specimen of this psammocharid wasp, collected by Mr. Weber at Hickam Field, April 13, 1949, was exhibited. It is a new immigrant to Hawaii, and occurs from India eastward to the Philippines. It was identified by Dr. J. C. Bequaert who compared the Oahu specimen with *T. ashmeadi* Brown, identified by Nathan Banks; Dr. Bequaert considers *ashmeadi* to be a synonym of *analis.* A series of this wasp was collected June 9 and 10 at Hickam Field by Messrs. Dyson, Maehler, Morrison and Stevens.

PRODENIA LITURA (F.)—This agrotid moth was taken at light on Palmyra Island by Dr. Bonnet on May 20, 1949; this is a new island record. Identification was by Dr. Swezey.

VANDUZEA SEGMENTATA (Fowler)—Mr. Look exhibited adults and nymphs of this recently introduced membracid found breeding on *Verbesina encelioides* at Kaimuki. He had also found the nymphs on a rose plant. Both are new host records.

EUTRETA XANTHOCHAETA Aldrich—Dr. Hardy exhibited specimens of the lantana gall fly reared from galls on Jamaica vervain (*Stachytarpheta jamaicensis*); this appears to be a new host record. On May 13 vervain near Kaneohe was heavily infested by this fly.

AONIDIELLA INORNATA McKenzie—Dr. Hardy exhibited specimens of the "yellow scale" collected by Mr. Tanada on rose bushes, a new host record. Although according to Zimmerman (Insects of Hawaii, 5:366) no parasites have been recorded from this scale in Hawaii, a large series of an unidentified eulophid was reared at the University. [This was sub-

sequently determined by A. B. Gahan as *Aphytis chrysomphali* (Mercet).] This scale resembles a *Chrysomphalus,* and has been confused in the local literature under the names *Aspidiotus* and *Chrysomphalus aurantii.* The female can be recognized by its reniform shape and the "pushed in" appearance of the pygidium.

EUXESTA SEMIFASCIATA Malloch—Dr. Hardy reported an ortalid fly not specifically reported from Oahu, until now, and previously unknown from Palmyra. A specimen of this species is from Lanikai, taken in light trap, December 3, 1945 (W. W. Wirth), and another was collected by sweeping on Palmyra Island, May 18, 1949 (D. D. Bonnet). Described from the Ellice Islands (Ins. of Samoa, 6:216, 1930) this fly is most closely related to *Euxesta binotata* Loew, from Cuba. The genus is not well developed in the Pacific.

PROTAETIA FUSCA (Herbst)—Mr. Maehler exhibited a large scarabaeid new to the Territory. It was first found by F. D. Morrison at Hickam Field nursery, June 9, 1949. Two specimens were taken on trees, and one in flight. This beetle occurs in India and Mauritius, and eastward in southeast Asia, the Dutch East Indies, the Philippines, North Queensland and Fiji. Arrow (Fauna British India, Coleop., Lamellicornia, Pt. 1:154, 1910) states that the larvae damage roots of cannas and other plants. It has been reported as breeding in vegetable refuse (Java) and in refuse from a coffee mill (Malaya). In Queensland it is said to attack *Cassia brewsteri,* and in Malaya to attack the roots of tub plants. It is reported to feed on male flowers of the coconut in Malaya, where it is parasitized by *Scolia vollenhoveni* Saussure. In Queensland the adults have been found to attack nests of a stingless bee, *Trigona,* probably for the honey.

CORISCUS PILOSULUS (Herrich-Schaeffer)—Mr. Maehler exhibited specimens of this recent immigrant corizid bug, captured on indigo at the base of Mt. Kaala. This is the second time this insect has been taken in the field here, the first being at Poamoho in May 1948, some four miles from where Mr. Maehler collected it.

NEW INSECT RECORDS FROM THE WESTERN PACIFIC—Mr. Maehler presented the following new island records:

HETEROPTERA

Megymenum affine Boisduval; Dublon, Truk, Feb. 1948; on cucumber; det. Usinger.
Mezira membranacea F.; Guam, Feb. 1, 1948; under bark; det. Usinger.
Anisops nasuta Fieber; Saipan, Jan. 1, 1948; in pool; det. Usinger.
Coleotichus breddini Schouteden; Saipan; Jan. 1, 1948; at light; det. Usinger.
Melanacanthus margineguttatus Distant; Saipan; Jan. 1, 1949; det. Usinger.

COLEOPTERA

Olenecamptus bilobus lacteoguttatus Fairmaire; Guam; Dec. 17, 1948; at light; det. Zimmerman.
Cassida sp.; Guam; Dec. 17, 1947; det. Zimmerman.
Epilachna philippinensis Dieke; Guam; Nov. 23, 1948; on leaves *Cestrum diurnum;* det. E. A. Chapin.
Adoretus sinicus Burmeister; Guam; Feb. 1949; at light; det. Maehler.

HYMENOPTERA

Xylocopa varipuncta Patton; Saipan; Jan. 1949; flowers of *Leucaena glauca;* det. Maehler.

Pachodynerus nasidens (Latreille); Yap; Feb. 1949; Koror, Palau, March 1948; both on *Crotalaria;* det. Maehler.

Ropalidia marginata sundaica van der Vecht; Koror, Palau, March 1948; det. Maehler.

Chalybion bengalense (Dahlbom); Guam, March 1949, on *Ipomoea;* det. Maehler.

DIPTERA

Aedes oakleyi Stone; Saipan; Jan. 1948; reared from water in can; det. A. Rudnick.

Aedomyia venustipes (Skuse); Yap; March 6, 1949; at light; det. W. C. Reeves.

FRUIT FLIES ON MAUI—Dr. Bess said that a recent survey on the slopes of Haleakala, Maui, shows the Mediterranean fruit fly to be common in peaches to an altitude of 2500 ft. There is no evidence that this fly is being displaced by the oriental fruit fly there.

JULY 11

The 523rd meeting was held at the H.S.P.A. Experiment Station on Monday, July 11, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Blalock, Bonnet, Clancy, French, Flitters, Fullaway, Hinman, Look, Marucci, Keck, Pemberton, Rosa, Sakimura, Schwabe, Swezey, Wallace and Weber.

Visitor: Walter Thomsen.

Dr. R. L. Doutt was elected a corresponding member.

PAPER

Mr. Fullaway presented his paper: "Description of a Brachymeria parasitic on Agonoxena argaula Meyr. in Samoa (Hymenoptera: Chalcididae)."

NOTES AND EXHIBITIONS

THRIPOCTENUS BRUI Vuillet—Dr. Swezey reported that this introduced thrips parasite was collected by Paul Baldwin from *Acacia koa* at 4400 ft. elevation in Hawaii National Park, Hawaii, April 2. It is known from all the islands of the group except Molokai, but Dr. Swezey said it was remarkable that it should have spread to so remote a region as the Park area. *Isoneurothrips fullawayi* (Moulton) was collected at the same time; both identifications were by Mr. Sakimura.

TRAMEA LACERATA Hagen—Dr. Swezey exhibited a large dragonfly which he had never caught or seen before, one rarely taken nowadays in the Territory. It was captured by Miss Dorothy Swezey at Barber's Point lighthouse on July 8, when several were seen in flight and alighting on plants near the shore.

CRYPTORHYNCHUS MANGIFERAE (F.)—Dr. Swezey reported on a heavy infestation of mango seeds by this mango weevil. In examining 259 seeds over a period from June 21 to July 9, 98.9 per cent were found to contain weevils in various stages: 97 larvae (mostly full grown), 104 pupae and 55 adults. Counts were from mangoes falling from day to day from a single large tree. This is a higher record than any made during the past years. Another tree with fewer fruits, ripening simultaneously, showed an infestation of only 84 per cent.

ECTEMNIUS POLYNESIALIS (Cameron)—Mr. Weber exhibited specimens of this crabronid wasp and remarked on its abundance about 14 miles south of Kilauea, Hawaii, where he collected a large series on June 21.

TACHYPOMPILUS ANALIS (F.)—Mr. Rosa exhibited four specimens of this psammocharid wasp taken in the Makiki district of Honolulu, June 24. Mr. Thomsen said he had also collected this wasp recently on the north side of the base of Mt. Kaala.

DIOCALANDRA TAITENSIS Guerin—Mr. Fullaway exhibited a coconut badly damaged by this weevil, which normally attacks the petioles and leaf stalks. He also showed some guavas from Lanikai, Oahu, russet in color due to feeding by an unidentified mite.

AUGUST 8

The 524th meeting was held at the H.S.P.A. Experiment Station on Monday, August 8, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Bonnet, Clancy, Fullaway, Hinman, Inada, Keck, Lewis, Look, Marucci, Pemberton, Ritchie, Rosa, Schwabe, Swezey, Tuthill, Van Zwaluwenburg and Weber.

Visitors: F. H. Haramoto, F. D. Morrison, G. D. Peterson, Jr., Walter Thomsen and N. D. Waters.

Stephen Au and G. D. Peterson, Jr., were nominated for membership.

NOTES AND EXHIBITIONS

VANDUZEA SEGMENTATA (Fowler)—Mr. Tanada reported finding all stages of this membracid on young macadamia seedlings (*Macadamia ternifolia*) at Poamoho, Oahu, on August 4. They were feeding at the bases of the petioles near the tip of the growing point; infestation was light and no injury to the plants was noted.

LEAFMINER IN HONEYSUCKLE—Dr. Swezey exhibited a new moth reared from leafmines in Japanese honeysuckle (*Lonicera japonica*). A heavy infestation was found in July of this year in a garden on Makiki Heights, Honolulu. The larva, after issuing from the mine, made its cocoon on the surface of the leaf; the adult moth issued about a month later, on August 7. More material is needed for determination. [This insect is

described as *Swezeyula lonicerae* in a paper in this issue of the "Proceedings" (p. 191 et seq.).]

BRACHYMERIA AGONOXENAE Fullaway—Dr. Swezey exhibited a specimen of this chalcid parasite, which issued July 26 from a cocoon of *Agonoxena argaula* Meyrick on coconut leaf from Lanihuli Drive, Honolulu. This is several miles from Kaala-wai where the parasite was released nearly a year ago after having been introduced from Tutuila, Samoa. This indicates that it is now established and spread. (For description of this parasite see p. 63 of this issue of the "Proceedings"; for breeding notes, see Proc. Haw. Ent. Soc., 13:447, 1949.) Dr. Swezey remarked that his seven-year-old tree showed excessive work of the larvae of the host moth. On a single leaf of 85 pairs of leaflets, every leaflet had feeding scars to indicate that there must have been at least 10 larvae feeding there over a period covering the life of the leaf, of a year or more. This would give a total of 1900 larvae for the whole leaf, and many thousand for the whole tree, though only a few larvae can be found at any one time.

LATRODECTUS MACTANS (F.)—Dr. Bonnet reported receiving a specimen of the black widow spider collected in mid-July, 1949, on Canton Island. This is a new island record.

ARGENTINE ANT—Mr. Peterson reported that recently a male *Iridomyrmex humilis* Mayr was captured at the Honolulu airport, a considerable extension of its range from the area near Ft. Shafter where it was previously known.

SEPTEMBER 12

The 525th meeting was held at the H.S.P.A. Experiment Station on Monday, September 12, at 2:00 p.m., with President Balock in the chair.

Members present: Balock, Bess, Bryan, Carter, Fullaway, Hardy, Inada, Keck, Pelot, Pemberton, Peterson, Rosa, Stout, Swezey, Tanada, Tuthill, Van Zwaluwenburg and Weber.

Visitors: F. H. Haramoto, L. F. Steiner, Walter Thomsen, N. D. Waters and A. B. Weir.

George D. Peterson, Jr., was elected a member, and Stephen Au, a corresponding member. The following were nominated: F. H. Haramoto, L. F. Steiner and N. D. Waters.

PAPER

A paper by Harold E. Box was presented: "The more Important Insect Pests of Sugar Cane in Northern Venezuela."

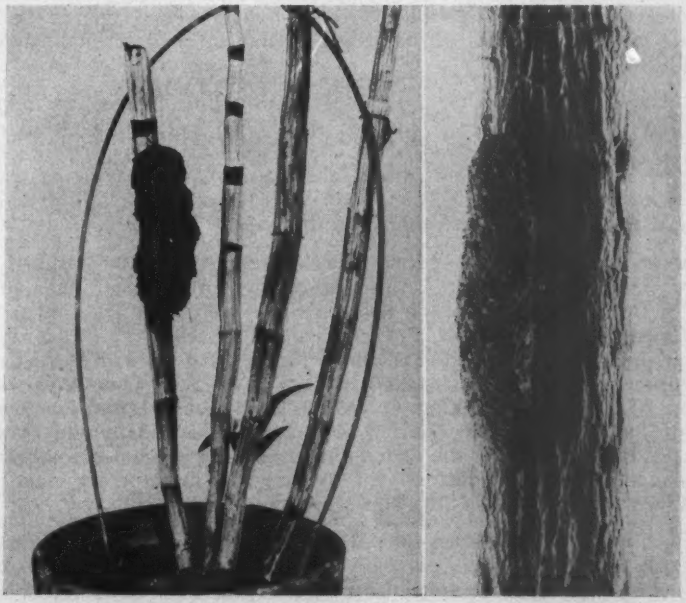
NOTES AND EXHIBITIONS

TUBIFERA AENEA (Scopoli)—Mr. Bryan reported recently seeing great numbers of this syrphid fly on *Sesuvium* foliage on Popoia Island (off Kailua, Oahu). This fly was formerly very abundant on Oahu, but has not been seen so frequently of late years.

SCATOPSE FUSCIPES Meigen—Dr. Hardy reported that this scatopsid fly is apparently well established in Hawaii. It is a scavenger, and Miss Inada has collected it in numbers about overripe papayas, mangoes and other fruits. Dr. Hardy has taken it at lights also. It is undoubtedly the species which Bryan (Proc. Haw. Ent. Soc., 8:406, 1934) reported as *Rhegmoclema atrata,* "captured on a parasite cage from California in 1915," but "not known to be established." *Rhegmoclema* has been placed in synonomy with *Scatopse,* and *atrata* Say is a synonym of *fuscipes* Meigen. Wirth reported this species in 1946 in light traps at Hickam Field and Honolulu. Dr. Alan Stone reports that specimens in the U. S. National Museum bear the following data: Volcano, Island of Hawaii, on *Calla* lily flowers, Jan. 12, 1944, and Honolulu, Oahu, quarantine in rotten potatoes from Canal Zone, 1920.

MANGO WEEVIL—Dr. Swezey reported that among 20 seeds of Haden mangoes recently examined, only one contained *Cryptorhynchus mangiferae* (F.).

EUMENES LATREILLEI PETIOLARIS (Schulz)—Dr. Swezey exhibited a nest of this wasp built on the trunk of a papaya tree. The material of which it is made closely matches the color of the trunk. (See figure.)



Left, nest of *Eumenes pyriformis philippinensis* Bequaert, on *Dendrobium.* Right, 7-celled nest of *Eumenes latreillei petiolaris* (Schulz), on papaya stem.

VOLUCELLA HOYA Curran—Mr. Weber reported rearing a specimen of this syrphid from overripe avocado.

OPIUS LONGICAUDATUS (Ashmead)—Mr. Weber reported rearing one specimen of this braconid from a number of galls of the tephritid, *Procecidochares utilis* Stone on pamakani (*Eupatorium*) from Mt. Tantalus, August 10. This is a new host record.

DICRANORHINA LUZONENSIS Rohwer—Mr. Weber exhibited a specimen of this larrid wasp, new to the Territory. It was taken by him in Honolulu, September 10, 1949. In the Philippines, according to Dr. Williams (H.S.P.A. Expt. Sta., Ent ser., Bull. 19:100, 1928), it nests in the ground, preying on a wood cricket, probably *Cycloptilus dewitzi* (Saussure).

TRYBLIOGRAPHA sp.—Mr. Weber exhibited a series of this cynipid parasite of *Dacus dorsalis* Hendel, found by Mr. Krauss in Malaya, and introduced into Hawaii this year. It attacks the larva and issues from the puparium; it has reproduced well on *dorsalis* in guava and rose apple, and appears to be a valuable parasite. It has been released from quarantine and will be liberated soon.

ARGENTINE ANT—Mr. Thomsen and Mr. Peterson reported the occurrence of this ant at Pearl Harbor, where there have been several swarms near the Fleet Post Office during the past three weeks. This is the farthest known extension of this ant's range from its original establishment at Ft. Shafter in 1940.

EUMERUS MARGINATUS Grimshaw—Mr. Pemberton reported rearing this syrphid from planted cane cuttings which had failed to germinate at Kailua, Oahu. The cuttings were completely covered with soil; when dug up they were sour and considerably decayed. The larvae were well developed when found on August 10. It is believed that failure to germinate was due to factors other than the syrphid infestation.

APION ULICIS (Forster)—Mr. Pemberton reported on the status of the gorse weevil in New Zealand, which he recently investigated there. Introduced from England, the weevil destroys from 90 to 99 per cent of the gorse seed in New Zealand, and has definitely checked the spread of the plant. By arrangement with Dr. David Miller of the Cawthron Institute, a shipment of the weevil arrived in Hawaii on September 8, of which some 2000 were alive. That same day 1500 were released at Olinda, Maui, and on September 10, 500 were liberated at Humuula, Hawaii. Mr. Look reported that the weevils began feeding on the gorse blossoms immediately after liberation. An unsuccessful attempt was made to establish this weevil in Hawaii in November 1926.

HONEYSUCKLE LEAFMINER—Mr. Rosa reported that this new moth, rerecently found attacking honeysuckle, and as yet unidentified,[1] has been found widespread in Honolulu: on Pacific Heights, Nuuanu Valley and Kalihi Valley. A eulophid parasite reared from the larva was identified

[1] *Swezeyula lonicerae* Zimmerman and Bradley; see page 191 of this issue of the "Proceedings."

by Mr. Fullaway as *Zagrammosoma flavolineata* Crawford (see Proc. U.S.N.M., 45:255, fig. 2, 1913). This is a new record for the Territory.

AGONOXENA ARGAULA Meyrick—Mr. Rosa said he had found this pest of coconut near Hauula, a considerable extension of its known range on Oahu. He also reported that a eulophid hyperparasite on *Brachymeria agonoxenae* Fullaway, in an *Agonoxena* cocoon, was identified by Mr. Fullaway as *Pleurotropis* sp.

OCTOBER 10

The 526th meeting was held at the H.S.P.A. Experiment Station on Monday, October 10, at 2:00 p.m., with President Balock in the chair.

Members present: Alicata, Balock, Bess, Bonnet, Carter, Chong, French, Fullaway, Haramoto, Hardy, Hinman, Inada, Keck, Look, Pelot, Pemberton, Rosa, Schwabe, Steiner, Swezey, Tanada, Tuthill, Van Zwaluwenburg, Waters and Weber.

Visitors: L. M. Chilson, G. L. Finney, C. T. Nihei, Martin Sherman, Gordon L. Smith, Harry S. Smith and Walter Thomsen.

Elected to membership in the Society were Frank H. Haramoto, Loren F. Steiner and Norman D. Waters. Nominated for membership were G. L. Finney, Dr. Martin Sherman and Gordon L. Smith.

NOTES AND EXHIBITIONS

EUMENES LATREILLEI PETIOLARIS (Schulz)—Dr. Swezey reported further on the wasp nest exhibited at the previous meeting. Wasps began emerging on September 13, and continued on September 15, 19, 21, 24 and 25, at intervals of from one to four days, for 12 days. This indicates the brief time it took the parent female to build and provision one cell after another.

EUMENES CAMPANIFORMIS (F.)—Dr. Swezey exhibited a male of this immigrant wasp, collected October 9 on low herbage near Barber's Point lighthouse. It was previously taken in the Pearl Harbor area, in Honolulu and Kahuku.

VANDUZEA SEGMENTATA (Fowler)—Dr. Swezey exhibited specimens of this recent immigrant membracid taken in numbers on *Verbesina* near Barber's Point; both nymphs and adults were found. This is a new locality record for this insect on Oahu.

DIRHINUS LUZONENSIS Rohwer—Mr. Weber exhibited specimens of this chalcid, not previously recorded from Hawaii. Specimens collected in 1920 are in the collection of the Board of Agriculture and Forestry, indicating that it has been here, unrecognized, for some time. It was described from the Philippines (Phil. Jl. Sci., 22:348, 1923) and probably parasitizes houseflies and other Diptera. A series was recently bred by Mr. Tanada from poultry manure.

MOTES ARGENTATUS (Beauvois)—This nearctic larrid wasp, new to the Territory, was taken by Mr. Weber at Hickam Field, Oahu, June 5, 1949. Mr. Krombein, who identified the specimen, says he has seen males collected by Richard Dow one mile northeast of Koko Head, Oahu, in 1945. It is said to prey on crickets.

OPIUS spp.—Mr. Weber reported that hundreds of two species of *Opius* collected from *Olea chrysophylla* in East Africa were recently received from Messrs. McGough and Skinner. Over 2400 have been released on the four larger islands. These wasps appear to be *Opius africanus* Szepligeti and *O. dacicida* Silvestri, both bred from olives by Silvestri on his 1913 expedition in search of fruit fly parasites.

DACUS DORSALIS Hendel—Mr. Weber reported that a species of *Pyrus*, probably *serotina*, can be added to the hostplants of the oriental fruit fly. From 28 fruits of this sandpear collected in Honolulu, 118 puparia were obtained, which produced 55 *D. dorsalis* and 50 *Opius longicaudatus* (Ashmead).

Dr. Bess said that recently at Olinda, Maui, peaches were free of both the oriental fruit fly and the Mediterranean fruit fly. On Maui at about 4000 ft. elevation, *dorsalis* was not very abundant. Dr. Bess remarked that *Ceratitis* is now found on Oahu below 500 ft., but that it is scarce; on Hawaii at 4000 ft. it is more abundant than *dorsalis*.

ANANCA BICOLOR (Fairmaire)—Dr. Bonnet reported the swarming of this oedemerid beetle October 3, at Keolu Hills, Oahu, clustering on a house under the eaves. The beetles dirtied the side of the house with their excrement; photographs of the clusters were shown.

ARGENTINE ANT—Mr. Pemberton reported finding thriving colonies of *Iridomyrmex humilis* Mayr in Nuuanu Valley, opposite the west end of Laimi Road. Mr. Thomsen also reported finding it in Nuuanu, as well as in Moanalua Gardens, Moanalua golf course and north Halawa Valley. On *Calliandra* it was attending colonies of *Vanduzea segmentata* (Fowler) and *Aphis gossypii* Glover. On *Ixora* and *Schinus* (Christmas berry) it was attending *Coccus viridis* (Green). At Halawa it was on sugarcane, associated with the pink mealybug, *Trionymus sacchari* (Cockerell). Prof. Harry S. Smith pointed out the possibility of this ant upsetting an established biological control, and cited the increase of certain citrus pests in areas where the Argentine ant is present in California.

BREVIPALPUS PAPAYENSIS Baker—Attention was called to the original description (Amer. Midland Nat., 42:375, Pl. X, figs. 84-86, 1949) of this pseudoleptid mite, from material taken on papaya by Mr. Look in 1941 on Oahu. What may be the same species was reported from camphor leaves in Washington, D. C., and from lemon in Cuba.

NEW WASP RECORDS—Mr. Van Zwaluwenburg reported seeing adults of *Ampulex compressa* (F.) and *Eumenes latreillei petiolaris* (Schulz) on Molokai, on September 14; both are new island records.

NOVEMBER 14

The 527th meeting was held at the H.S.P.A. Experiment Station on Monday, November 14, at 2:00 p.m., with Vice-President Tuthill in the chair.

Members present: Bess, Bryan, Chong, Clancy, Fullaway, Haramoto, Hardy, Hinman, Hu, Inada, Keck, Look, Marlowe, Marucci, Newell, Pelot, Pemberton, Rosa, Sakimura, Sherman, Swezey, Tanada, Tuthill and Van Zwaluwenburg.

Visitors: L. M. Chilson, Randall Latta, R. L. Metcalf, C. T. Nihei, Walter Thomsen and Robert van den Bosch.

David T. Fullaway and Harry S. Smith were elected honorary members of the Society.

Elected to membership were G. L. Finney, Dr. Martin Sherman and Gordon L. Smith. Nominated for membership were L. M. Chilson, Walter Thomsen and Robert van den Bosch, and C. T. Nihei for associate membership.

PAPER

Mr. Bryan presented a biographical sketch of the late Dr. J. F. Illingworth.

NOTES AND EXHIBITIONS

PLOVER PREDACEOUS ON ANOMALA—Mr. Sakimura reported that the Pacific golden plover (*Pluvialis dominica fulva*) has been observed to be an efficient predator on adult *Anomala orientalis* (Waterhouse). Dr. Carter noted a concentration of this migratory bird in pineapple fields in the upper Kunia section of Oahu, and observed *Anomala* elytra in their droppings. A later survey showed as many as 124 to 183 droppings in 50 feet of 10-ft. road, and every dropping examined consisted entirely of macerated *Anomala* beetles. High incidence of plover droppings was associated with high *Anomala* grub populations. 124 to 183 droppings were found where the grub index was between 30 to 35; 47 to 73 where the index was 10 to 20; and 6 to 24 where the index was 0 to 6. The *Anomala* index is the total number of grubs in nine samples of soil columns, 6 inches in diameter and 12 inches deep.

SCALES ON CHRYSALIDOCARPUS—Miss Pelot reported that on three leaves of a small golden-fruited palm (*Chrysalidocarpus lutescens*) she found six species of scale insects. In each case this palm proves to be a new host record:

Parlatoria proteus (Curtis)
Diaspis boisduvalii Signoret
Chrysomphalus dictyospermi (Morgan)
Ischnaspis longirostris (Signoret)
Phenacaspis sandwicensis (Fullaway)
Hemiberlesia lataniae (Signoret)

EUMENES LATREILLEI PETIOLARIS (Schulz)—Dr. Swezey reported a new island record for this immigrant wasp. Mrs. Hilda F. Swezey found it at Lahaina, Maui, and recognized it from her previous acquaintance with it at Waianae. Later this wasp was seen at Haiku and at Makawao, Maui.

APHYCUS ALBERTI Howard—Dr. Swezey exhibited specimens of this encyrtid parasite of scales, collected on mamani (*Sophora chrysophylla*) foliage August 17, at 3000 ft. elevation in the National Park on Hawaii, by Paul Baldwin. It is an insect seldom recorded in these islands. Dr. Swezey reared it in 1914 from *Coccus elongatus* (Signoret) in Honolulu, which, according to Timberlake, was the first record from the Territory. Apparently it has not been recorded from the island of Hawaii until now.

NEW ORIENTAL FRUIT FLY HOST—Dr. Bess reported that Miss Inada recently reared 9 *Dacus dorsalis* Hendel and 132 *Ceratitis capitata* (Wiedemann) adults from 40 English walnuts from Waikii, Hawaii. Walnuts collected on Maui were infested by the Mediterranean fruit fly.

OPIUS LONGICAUDATUS (Ashmead)—At an earlier meeting Dr. Bess had reported this opiine in relatively large numbers early in October at various places on Maui up to about 3000 feet. He now reported that Mr. Murakami had revisited these same places early in November and failed to find a single parasite in the upper Kula region where they were conspicuously abundant a month before.

NEW CHRYSIDID WASP—Mr. Pemberton exhibited specimens of a chrysidid wasp new to these islands, tentatively determined as *Chrysis fuscipennis* Brullé. It was first taken at Foster Garden, Honolulu, October 14, 1949, by Colin Potter.

BETHYLID IN INFESTED BOOKS—Dr. Hardy exhibited specimens of Bethylidae found in considerable numbers in termite galleries in books in the University library. These wasps were probably parasitizing Anobiidae, although no beetles were found in the books. The parasites are *Cephalonomia gallicola* Ashmead; Mr. Muesebeck, who identified them, states that it is possible that *C. peregrina* Westwood is the same species, but that definite determination of that point is impossible from the description, which is very inadequate. He says: "I prefer, therefore, to apply a name which I know does fit these specimens. *C. gallicola* has been received here from many different parts of the world. Apparently it has been widely distributed in commerce."

DECEMBER 12

The 528th meeting was held at the H.S.P.A. Experiment Station on Monday, December 12, at 2:00 p.m., with Vice-President Tuthill in the chair.

Members present: Carter, Chong, Fullaway, Haramoto, Hardy, Hu, Inada, Keck, Look, Newell, Nihei, Pelot, Pemberton, Rosa, Sakimura, Schwabe, Sherman, Swezey, Tanada, Tuthill, van den Bosch and Van Zwaluwenburg.

Visitor: Francis Rathburn.

La Mar Chilson, Walter Thomsen and Robert van den Bosch were elected active members, and Clarence T. Nihei an associate member. Francis Rathburn was nominated for associate membership.

A slate of officers for 1950 was presented, and elected to office as follows:

President.....C. E. Pemberton
Vice-President.....Yoshinori Tanada
Secretary-Treasurer.....R. H. Van Zwaluwenburg
Members of Executive Committee.....J. W. Balock, D. E. Hardy

PAPERS

Papers by the following authors were presented: H. A. Bess, D. D. Bonnet, W. E. China and R. L. Usinger, L. J. Dumbleton, D. T. Fullaway, D. Elmo Hardy, D. D. Jensen, K. V. Krombein, P. E. Marucci and D. W. Clancy, S. Maulik, K. Sakimura, C. W. Schwabe, E. C. Zimmerman and O. H. Swezey.

NOTES AND EXHIBITIONS

PINNASPIS BUXI (Bouché)—Dr. Swezey exhibited an *Anthurium* leaf infested with this scale insect. It is an additional hostplant to those reported by Zimmerman in "Insects of Hawaii." The scale was identified by Mr. Fullaway.

DIARTHRONOMYIA CHRYSANTHEMI Ahlberg—Dr. Hardy reported that the chrysanthemum gall midge is apparently a new immigrant to Oahu. Samples of chrysanthemum plants were obtained recently in Palolo Valley; these were heavily infested, but it was impossible to determine the source of the infestation. The plants had come from Waipahu some two years ago, but were not infested then. It seems probable that the trouble originated rather recently in Palolo. The only other record of this fly in Hawaii is that of Mr. Look (Proc. Haw. Ent. Soc., 13:332, 1949) who reported a heavy infestation on chrysanthemums grown under glass at Hilo, Hawaii.

This insect is a serious pest of chrysanthemums. It is normally considered a greenhouse pest; this is the first time Dr. Hardy has seen it on plants grown out of doors. The Palolo specimens were heavily parasitized by *Charitopodinus swezeyi* (Crawford) (Eupelmidae; det. A. B. Gahan) and *Platygaster* sp. (Scelionidae; det. C. F. W. Muesebeck). No parasites of this midge have previously been reported from Hawaii.

TOXIC REACTION TO SPIDER BITE—Dr. Hardy reported that on November 21, a spider was submitted for identification which had bitten a woman on the eye lid at 1:30 a.m. the night before. She had experienced rather severe symptoms; the bite was very painful and the affected areas swelled up immediately. She was given emergency treatment at the hospital at about 2:00 a.m., but suffered intense pain all night and was nauseated. The following day (12:30 p.m.) the eye lid was red, swollen and very sore. The intense pain persisted and she was still nauseated to some extent, and had been unable to eat. The specimen was identified by Dr.

Willis J. Gertsch of the American Museum as *Chiracanthium* sp.? (Family Clubionidae); he was unable to place it to species from the single female specimen. Dr. Gertsch says that up to the present time no species of this genus has been recorded from Hawaii, and so it follows that this would be a new species, if it were an endemic one. Dr. Gertsch says that the European species, *Chiracanthium nutrix*, has been credited with causing distressing symptoms, but to his knowledge there are no other records of injurious bites from members of this genus.

IRIDOMYRMEX HUMILIS Mayr—Mr. Thomsen reported finding the Argentine ant in a sugar cane field at Ewa Plantation Co. in November. Mr. Pemberton added that, following information from Mr. Thomsen, the Ewa area was scouted and the ant found to occupy practically all of the plantation from Pump 10 to the western end, a distance of nearly two miles. It is suggested that the original focus of infestation was an Army camp, since abandoned, in the kiawe growth a short distance away, where the ant is still numerous.

PROTAETIA FUSCA (Herbst)—Mr. Chilson reported an extension of the known local range of this cetoniine beetle on Oahu. In November he found adults on corn tassels, and larvae in compost at Moanalua Gardens. He has also taken the adults feeding on the blossoms of mango, yellow ginger and candle flower (*Cassia alata*).

LAEMOPHLOEUS MINUTUS (Olivier)—Mr. Fullaway reported finding this cucujid beetle recently in wheat at the plant quarantine office in Honolulu. It does not agree with specimens so named in local collections, but does agree with the figure of that species given in Back and Cotton's "Stored-Grain Pests" (Farmers' Bull. 1260, revised, p. 24, fig. 32, 1938).

OLIARUS VAFER Fennah—Attention was called to the description of this new cixiid described (Ann. Mag. Nat. Hist., ser. 12, 2:589, figs. 3 a-e, 1949) from Hiva-oa in the Marquesas. It is closest to *O. swezeyi* Giffard and *O. muiri* Giffard, but differs from both in the shape of the male genitalia.

DACUS DORSALIS Hendel—Dr. Carter summarized a study of various species of *Vanda* orchids with respect to oviposition by the oriental fruit fly. In some 20,000 culled blossoms of *Vanda Miss Joaquim*, 20 *dorsalis* eggs were found; among 12,500 culls of other species of *Vanda*, 8 eggs were found. He stressed the fact that eggs were found only in blossoms culled, for one reason or another, before packing.

MELON FLY—Mr. Tanada reported finding in a field at Mokuleia, an exposed Irish potato with 11 fly eggs, on November 2. The eggs were in a small cavity resulting from a breakdown of the tissues just under the epidermis. All eggs hatched in the tuber, but six maggots left in the potato died within a few days, after attempting to feed. The other five maggots were reared to adult *Dacus cucurbitae* Coquillett on papaya by Miss Inada.

JAMES FRANKLIN ILLINGWORTH, 1870-1949

(Presented at the meeting of November 14, 1949)

Dr. J. F. Illingworth, for 37 years (1912 to 1949) a member of the Hawaiian Entomological Society, died on August 31, 1949, at the home of his daughter in Santa Ana, California. The members of the Society wish to pay tribute to the valuable contributions he made to the economic entomology of the Hawaiian Islands and other lands in and around the Pacific.

He was born in Lanark, Illinois, May 11, 1870. After receiving degrees from Pomona College (B.S. 1900) and Stanford University (A.M. 1901), he taught biology for nine years in a high school in Seattle, Washington. He then went to Cornell University, where he was granted the degree of Doctor of Philosophy in 1910.

During his years in Seattle, he was much interested in the conservation of wild life. As president of the Washington State Audubon Society, he published feature articles in the Seattle Sunday Times: "Help the Birds build their Spring Homes" (May 2, 1909) and "Protecting Wild Animals" (July 18, 1909).

From 1912 to 1917, Dr. Illingworth was professor of entomology at the College of Hawaii. Besides studying various insect pests in Hawaii, he also went to Fiji, where he introduced parasites of sugar cane pests for the Colonial Sugar Refining Company. This led to his going to Queensland, Australia, where, from 1917 to 1921, he investigated sugar cane pests for the Queensland government. He spent the period from 1922 to 1924 in Japan and China, making entomological studies for the U. S. Department of Agriculture.

In 1922 Dr. Illingworth became a research associate in entomology with Bernice P. Bishop Museum, where he made his headquarters when in Honolulu. This association continued until 1943, during which time he contributed thousands of insect specimens to the Museum's collections. Many of his entomological papers were written there. An interest in the background and growth of economic entomology in Hawaii lead to a paper, "Early references to Hawaiian entomology," published as Bulletin 2 of the Museum, in 1923. A large part of Dr. Illingworth's other papers on Hawaiian entomology were printed in the Proceedings of the Hawaiian Entomological Society, a total of about 50 from 1913 to 1942.

From 1926 to 1930, Dr. Illingworth was entomologist for the Association of Hawaiian Pineapple Canners. He moved to California soon after the start of the war in the Pacific, and settled on a ranch near Santa Ana. Always ready to help students and home owners with entomological problems, he will be remembered by a large circle of friends and acquaintances as well as by his colleagues in the various scientific institutions of Hawaii.

E. H. BRYAN, JR.

NOTES ON PARASITES OF TEPHRITID FLIES

Some of the recently introduced opiine parasites of the oriental fruit fly were recovered from fruits collected in December in 10 of 15 liberation areas on Oahu in which *Opius longicaudatus* (Ashmead) and *O. persulcatus* (Silvestri) were released earlier. *O. longicaudatus* was seen ovipositing in guava, banana, star apple and breadfruit at five release points: Kaalaea, Luluku, Mokuleia, Nuuanu and Woodlawn. Adults were reared from guava, tangerine, strawberry guava and false kamani. Adults of *longicaudatus* were relatively numerous at Kaalaea, Luluku and Woodlawn. On a number of fruits four to six females were observed ovipositing simultaneously. *O. persulcatus* was recovered only from guava collected about one-fifth of a mile from the point of liberation in Luluku Valley.

GORDON B. MAINLAND. January 10.

Encouraging recoveries of *Opius longicaudatus* were made on Oahu during the first quarter of 1949. Twenty recoveries were made from fruit in the vicinity of parasite release points, and at two others females were observed ovipositing. In addition, *longicaudatus* was recovered at Foster Garden, the University substation at Poamoho and on the University campus. The parasite no doubt migrated into Foster Garden and Poamoho from release points, while those on the campus were probably progeny of laboratory escapes. Apparently *longicaudatus* is spreading; at Kaalaea and Luluku it has spread at least one-quarter of a mile from release points; at Waimea it has spread one mile up the valley, and at Poamoho it has apparently moved four miles from the nearest release point near Haleiwa.

Evidently fruit size and ripeness influence the percentage of parasitization. From a collection of coffee berries from Waimea Valley, 74 per cent of the *Dacus dorsalis* puparia yielded *O. longicaudatus,* while in the common guava parasitization varies from about 2 per cent in fruit beginning to ripen on the tree, to 50 per cent in soft fruit on the ground. On the University campus parasitization in Surinam cherries was 59 per cent in 192 fruits from the ground, and 24 per cent in 152 ripe fruits from the tree. To date *longicaudatus* seems to be more abundant in fairly wet areas at low elevations than in drier regions or in moist areas at higher elevations. At Woodlawn nine females were observed on a single medium-sized guava.

Opius persulcatus was recovered at Foster Garden and at Luluku, in addition to recoveries by the Board of Agriculture & Forestry from its Makiki grounds, and from the Duncan Tract. Two adults were reared from fruit from Luluku, and 13 from Foster Garden. It was the only parasite reared from small *Zizyphus jujuba* fruits from the latter site. No authenticated recoveries of *Opius incisi* Silvestri have yet been made.

GORDON B. MAINLAND. April 11.

Specimens of what was considered *Opius longicaudatus,* reared from the oriental fruit fly, were sent to C. F. W. Muesebeck for checking. On March 31 he reported that the specimens were *Opius comperei* (Viereck), and stated that this species was previously represented in the National Museum collection only by the type and paratype from India. A larger lot of this *Opius* was thereupon sent Mr. Muesebeck for further checking. It consisted of a series reared from *D. dorsalis* at various localities on Oahu, a series from a mass-rearing culture maintained by the Board of Agriculture & Forestry (including the original imported female and her first progeny), and a series from material collected by Krauss at Kuala Lumpur, Malaya. On May 6 Mr. Muesebeck reported that all the Hawaiian specimens agree with *comperei,* whereas the material from Kuala Lumpur was mostly *longicaudatus.* Later, on May 26, Mr. Muesebeck wrote that the original female from Kuala Lumpur matches the type of *O. comperei* perfectly, but that the first generation progeny are the same as *longicaudatus.* "I have come to the conclusion," he writes, "after pretty careful study of all available material, that I cannot satisfactorily distinguish two species there. I believe we must consider *comperei* a synonym of *longicaudatus,* even though the type specimens covered by the two names are quite different, especially in the color of the legs."

D. ELMO HARDY. May 9.

The following is a summary of fruit fly parasite shipments made during the past year. Eighty-five shipments containing 339,092 fruit fly puparia were received from Mr. Krauss in Malaya between June 10, 1948, and May 18, 1949. The first 75 shipments were from Kuala Lumpur and vicinity, the last ten from Singapore Island. The great majority, 303,625 puparia, were of *Dacus dorsalis* from carambola, *Solanum* spp., chilli, *Eugenia* sp. and mango. These produced the following adult parasites:

Opius persulcatus	13,905
" incisi	2,615
" longicaudatus	587
Pachycrepoideus dubius	625
Tachinaephagus (spp.)	442
Syntomosphyrum indicum	299
Spalangia philippinensis and S.sp., near simplex	189
Trybliographa sp., **Pseudeucoila sp.**, **Pilinothrix sp.** cynipids	19
Galesus sp.	7

Thus 18,688 oriental fruit fly parasites comprising 13 species were obtained from Malaya within the past 11 months.

These shipments also produced three other species of Tephritidae and their parasites, as follows: 83 *Opius fletcheri,* 40 *Spalangia* spp., and 4 *Tachinaephagus* issued from approximately 26,000 melon fly puparia from cucumber, *Luffa cylindrica* and various mixed cucurbits. 33 cynipids and 4 *Tachinaephagus* sp. emerged from 8,158 puparia of *Dacus* (*Chaetodacus*) *umbrosus* infesting *Artocarpus polyphema,* while 989

puparia of *Dacus* (*Zeugodacus*) *caudatus* from *Lagenaria vulgaris* were unparasitized.

Mr. Krauss then moved to Australia where he is now stationed at Cairns, Queensland. His first two shipments arrived the latter part of June, containing 7,549 puparia from fruits of *Solanum auriculatum, Planchonella* sp., *Endiandra tooram* and banana. The emerging flies consist of several species of *Dacus* according to Dr. Hardy, including the Australian "*dorsalis*" which differs from true *dorsalis* as found in Hawaii and elsewhere. These have already produced five different species of *Opius* as yet unidentified, which are being tested on the three species of fruit fly in Hawaii. Additional shipments are arriving at the rate of about two each week.

Early in May Mr. Gardner at Hoboken, N. J., received a quantity of fruit fly puparia collected by Messrs. McGough and Skinner from various cucurbits at Pietermaritzburg, Natal Province, Union of South Africa. These were reared at Hoboken and the emerging parasites sent to Honolulu. Two shipments totalling 97 *Opius* (apparently 2 species, not yet identified) and 128 *Tetrastichus* (probably *T. giffardianus*) arrived May 20 and June 1, with 84 *Opius* and 66 *Tetrastichus* still alive. These are also being tested on the local fruit flies.

The first three shipments from India arrived during June. These contained 10,600 puparia of an unknown tephritid collected from *Berberis vulgaris* by Messrs. Bianchi and Newell near Ranikhet, United Provinces, in northern India. Unfortunately, this appears to be a single-brooded species and the puparia are in diapause; various methods of breaking the diapause are being tried.

D. W. CLANCY. July 11.

During May Dr. Mainland observed numerous females of *Opius tryoni* Cameron, a parasite of the Mediterranean fruit fly, ovipositing in wild guavas infested with *Dacus dorsalis*, near Kaneohe, Oahu. Although several large recovery collections were made at this location, including the same fruits on which he had seen the parasites working, he was not able to rear any *tryoni*. Since *Ceratitis* has become extremely rare in this area, the occurrence of its parasite in large numbers was puzzling. It was noted however, that a heavy growth of lantana was present, infested by the gall fly, *Eutreta xanthochaeta* Aldrich, which recently (Bien. Rpt. Hawaii Agr. Expt. Sta., 1946-48:77; Proc. Haw. Ent. Soc. 13:319, 1949) has been reported as a host of *O. tryoni*. We confirmed these records by collecting 115 galls which later produced both insects. *O. tryoni* was also commonly seen ovipositing in guavas at other places, generally near lantana and vervain (*Verbena litoralis*) bearing *Eutreta* galls. A total of 76 adult *O. tryoni* (69 females) were then collected in the field and caged with several lots of guavas heavily infested with *Dacus dorsalis* in an attempt to propagate this species on the oriental fruit fly. However, only two *O. tryoni* were obtained from 820 puparia, indicating that *D. dorsalis* is not normally a host of this parasite even though it is readily attacked in nature.

Opius tryoni rather closely resembles *O. longicaudatus,* with which it is often associated in the field; in fact, females of both species have been seen ovipositing in the same ripe guava. All recoveries of *longicaudatus,* particularly those based on field observations only, should therefore be carefully checked in order to avoid possible misidentification.

D. W. CLANCY. August 8.

Pamakani (*Eupatorium glandulosum*) occurs over a wide range of ecological conditions on Maui, and in all areas examined there the introduced tephritid gall fly, *Procecidochares utilis* Stone, occurs with it. However, the fly is conspicuously more abundant in some localities than in others; along the leeward slopes of Haleakala there are areas where the pamakani is very heavily galled and appears to be actually killed by the fly. In hope of getting concrete information on the abundance of the fly throughout the island, and on the cause of its scarcity in many localities, during field work on the ecology and biological control of the various fruit flies, observations and collections of pamakani stem galls were made at various localities on Maui during the past summer. Nine collections were made in July and sent to the Univeristy at Honolulu for rearing. In the following list of recoveries made, the figures in the extreme righthand column, "Per cent parasitized," are based on the number of adult flies and parasites obtained from the individual lots.

Collection point	No. of P. utilis	No. of Microbracon terryi	No. of Eurytoma sp.	No. of Eupelmus sp.	Per cent Parasitized
Waihou	273	5	22	1	9.3
Ulupalakua Ranch	120	23	49	0	41.7
Kipahulu	18	2	67	13	84.0
North Hana A	6	1	2	14	73.0
North Hana B	17	2	8	0	37.0
South Keanae	75	4	22	0	26.5
Keanae	34	0	14	0	29.2
Iao Valley	104	8	54	15	42.5
Olinda	121	216	78	21	72.2

Microbracon terryi Bridwell was determined by Mr. Muesebeck, and *Eurytoma* and *Eupelmus* by Mr. Gahan. From the South Keanae material one *Opius tryoni* also was reared.

The low parasitization at Waihou, where the pamakani is heavily galled and dying out, is interesting, as is the high parasitization in some localities where the fly is relatively scarce and the pamakani luxuriant. More collections were made at some of the same localities during the first week of October, and further observations and studies are planned to throw more light on the possible importance of the parasites in preventing the gall fly from becoming abundant in certain localities.

HENRY A. BESS. October 10.

It has been rather generally assumed that *Opius longicaudatus* will oviposit only in larger host larvae—from about one-half to full-grown—as do most other species of *Opius* that have been investigated. Recently,

however, we obtained a number of adult *longicaudatus* from *Dacus dorsalis* larvae dissected from field-collected kamani (*Terminalia*) nuts as first instars and reared to maturity on agar media. In order to verify this we then exposed separate agar cultures of first, second and third instar oriental fruit fly larvae to ovipositing female *longicaudatus* for 24-hour periods. Oviposition occurred with equal readiness in each series, and there was no significant difference in the number of progeny obtained according to host instar attacked. The ability of *longicaudatus* to parasitize first instar larvae may have considerable economic significance. At this stage the larvae are just under the skin of the fruit and therefore most vulnerable to attack, especially in larger fruits such as mangoes and avocados where most of them soon penetrate beyond reach of the parasites.

In August several lots of infested peaches from Maui were obtained from Miss Inada of the University of Hawaii Agricultural Experiment Station for experimental parasitization tests. These yielded a total of 383 *Ceratitis capitata,* 27 *Opius longicaudatus* and only 4 *Dacus dorsalis,* indicating that *longicaudatus* may have developed as a parasite in the Mediterranean fruit fly rather than *D. dorsalis,* its normal host. This possibility was therefore checked by exposing pure Med-fly cultures in agar media to *longicaudatus.* Oviposition was readily obtained and a number of adult *longicaudatus* issued from these tests—definite proof that this species can successfully parasitize *C. capitata.*

Increasing numbers of *Opius persulcatus* have been reared during the past two months from a wide variety of fruits collected at various points on Oahu. These fruits were used in breeding tests with other foreign parasite species, and the *persulcatus* records are, therefore, incidental. We have reared *persulcatus* from guava, rose apple, kamani, strawberry guava, mountain apple and passion fruit, generally in numbers considerably below those of *O. longicaudatus,* although several lots actually yielded more *persulcatus* than *longicaudatus.* Both species have been observed in the field ovipositing in the same fruits. In the original shipments from Malaya, *persulcatus* was always far more numerous than *longicaudatus*—with a ratio of about 23 to 1. It will, therefore, be interesting to see how these species ultimately compare in effectiveness here after populations become stabilized.

D. W. CLANCY. October 10.

Examination of Mr. Krauss' shipments of fruit fly parasites from Australia reveals that some species, earlier considered different, represent the same parasite from different host fruits or different localities. Reduced to five species, three of these prove to be new species (*Opius deeralensis, O. perkinsi* and *O. froggatti,* described by Mr. Fullaway in this issue of these "Proceedings," pp. 65-67), while two are considered forms of species previously described: *Opius longicaudatus* (Ashmead) and *O. fletcheri* Silvestri. Of the parasites imported to control fruit flies in Hawaii, the species identity and distribution appears to be as follows:

Opius longicaudatus is perhaps the same as *O. formosanus* Fullaway; from the Philippines, Malaya, Australia, Formosa, the Marianas, New Guinea and India.

Opius persulcatus (Silvestri) is the same as *O. javanus* Fullaway, and possibly the same as *O. arisanus* Sonan; from the Philippines, Malaya, Australia, Formosa (?), Java and India.

Opius fletcheri is possibly the same as *O. incisi* Silvestri and *O. fijiensis* Fullaway; from India, Malaya, Australia, New Guinea and Fiji.

D. T. FULLAWAY. December 12.

Progress and Status of Two Recently Introduced Parasites of the Oriental Fruit Fly, Dacus dorsalis Hendel, in Hawaii[1]

By H. A. BESS, ROBERT VAN DEN BOSCH, and FRANK HARAMOTO

UNIVERSITY OF HAWAII AGRICULTURAL EXPERIMENT STATION

(Presented at the meeting of December 12, 1949)

In June of 1948, N. L. H. Krauss, Entomologist with the Territorial Board of Agriculture and Forestry, began shipping fruit fly puparia containing parasites to Honolulu from Malaya. Two of the braconids, *Opius persulcatus* (Silvestri) and *Opius longicaudatus* (Ashmead), reared from the puparia were released in relatively large numbers throughout the Territory during the following twelve months. The establishment, spread and increase in abundance of these parasites have been studied fairly intensively since the initial releases were made.[2] This paper shows the progress and status of these parasites in Hawaii through 1949.

RELEASES

Table 1 summarizes the numbers of *O. persulcatus* and *O. longicaudatus* that have been liberated in the Territory and on Oahu where more intensive studies have been made on their establishment, spread, and abundance. The early releases were predominantly *O. longicaudatus*. However, several small liberations of *O. persulcatus* were made during the fall and winter of 1948-49 in the general vicinity where the bulk of the information given in this paper was obtained.

Table 1.—Summary of liberations of O. longicaudatus and O. persulcatus in Hawaii.[3]

Liberations	No. parasites liberated[3]			
	O. persulcatus		O. longicaudatus	
	Oahu	all islands	Oahu	all islands
July-Sept., 1948	65	65	1,414	1,714
Oct.-Dec., 1948	1,357	1,482	18,494	40,058
Jan.-Mar., 1949	665	5,281	5,543	18,138
Apr.-June, 1949	10,593	14,208	10,675	22,660
July-Sept., 1949	200	1,634	5,488	21,781
TOTAL	12,880	22,670	41,614	104,351

[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 194.

[2] G. B. Mainland and S. Shimono, former members of the entomological staff, obtained an appreciable part of the information presented on the establishment and spread of the two parasites during the fall and winter of 1948-49, and spring of 1949.

[3] All parasite liberations were made by the Board of Agriculture and Forestry.

ESTABLISHMENT AND SPREAD OF PARASITES

Within a few weeks after liberation of *O. longicaudatus* recoveries were made from fruits collected at several liberation sites and adults were also readily observed at these places. Furthermore, the parasites spread to a distance of at least one-quarter mile within two months after liberation and one to four miles in four months. By the fall of 1949, *O. longicaudatus* adults were commonly seen on mangoes and other fruits throughout the island of Oahu, and at a number of places on Hawaii, Kauai, and Maui.

O. persulcatus apparently became established from the small liberations made in the fall and winter of 1948-49 but until the fall of 1949 was recovered from only a few places. However, it has now spread a distance of at least six miles from two different liberation points and occurs generally throughout the Honolulu, Kailua, and Waimanalo areas on Oahu. To date it has been recovered on the outer islands only in the vicinities of a few liberation points.

INCREASE IN ABUNDANCE OF PARASITES

O. longicaudatus increased rapidly after its release in Manoa Valley (Table 2) and similar increases were observed in several other liberation areas. Parasitization by this species was frequently as high as 50 per cent

Table 2.—Parasitization of D. dorsalis from guava fruits collected in Manoa Valley (Oahu).

Date	No. in sample	No. parasitized by		Total per cent parasitized	Ratio of persulcatus to longicaudatus
		O. persulcatus	O. longicaudatus		
12- 1-48	727	0	1	0.1	....
12-15-48	206	0	41	19.9	....
2-16-49	722	0	31	4.3	....
4- 5-49	581	0	313	53.9	....
7-29-49	215	19	78	45.1	0.2
9- 9-49	340	272	32	89.4	8.5
10-25-49	476	351	42	82.6	8.4
12- 2-49	192	138	17	85.2	8.1
12- 7-49	246	159	49	84.6	3.2

in fruit collections made in the spring and summer of 1949 on Oahu. The increase on the outer islands has been slower but in a few localities parasitization has exceeded 40 per cent. During the late spring and summer of 1949, the adults of this parasite became conspicuously abundant locally at several places on Oahu and Maui. In these areas hundreds of adults could be seen flying over and resting on low vegetation. However, where close examinations were made, it was found that males predominated in these high populations. In early October *O. longicaudatus* adults (males and females) were seen generally on the slopes of Haleakala (Maui) below 3,000 feet elevation. However, fruit collections at that time indicated

that parasitization was for the most part below 50 per cent. Furthermore, collections made at the same places a month later gave parasitization of less than 10 per cent.

In the shipments from Malaya, *O. persulcatus* predominated to the extent of about 22 to 1.[4] In Hawaii the initial increase of *O. persulcatus* was considerably slower than that of *O. longicaudatus*. However, relatively few of the former species were liberated until late in the spring of 1949. As stated above, prior to the fall of 1949 *O. persulcatus* had only been recovered in numbers from a few localized areas. Nevertheless, collections made in Manoa Valley (Table 2), Waimanalo (Table 3) and at points throughout a large part of Oahu (Table 4) in the fall of 1949 revealed that *O. persulcatus* had increased in abundance tremendously. In can be

Table 3.—Parasitization of D. dorsalis from guava fruits collected at Waimanalo, Oahu.

Date	No. in sample	No. parasitized by		Total per cent parasitized	Ratio of persulcatus to longicaudatus
		O. persulcatus	O. longicaudatus		
6- 7-10-49	354	61	74	38.1	0.8
9-20-49	135	34	15	36.3	2.3
10- 5-49	111	67	7	66.6	9.6
11- 7-49	403	248	25	67.7	9.9
12-13-49	335	192	49	71.9	3.9

Table 4.—Summary of parasitization of different instars of D. dorsalis by O. persulcatus and O. longicaudatus from 52 collections taken on Oahu during October, November, and December, 1949.

Instar	No. flies emerged	No. parasites emerged		Per cent parasitized by		Total parasitization
		O. persulcatus	O. longicaudatus	O. persulcatus	O. longicaudatus	
1st	406	192	12	31.5	2.0	33.5
2nd	2,317	1,501	335	36.1	8.1	44.2
3rd	2,031	1,914	866	39.8	18.0	57.8
TOTAL	4,754	3,607	1,213	37.7	12.7	50.4

seen from Table 2 that in the samples taken from Manoa Valley in September, October and December, 1949, *O. persulcatus* alone parasitized 65 to 80 per cent of the larvae of *D. dorsalis*. Many other collections taken on Oahu during this period gave similar high percentages of parasitization by this species. Not only has *O. persulcatus* increased in relative abundance during the fall and winter of 1949 but there has been a great increase in the ratio of this species to *O. longicaudatus*. The combined parasitization by the two species in several collections has exceeded 80 per cent.

[4] Figures obtained from records submitted by the Territorial Board of Agriculture and Forestry and from the U. S. Bureau of Entomology and Plant Quarantine.

PARASITES REARED FROM DIFFERENT LARVAL INSTARS

During October, November, and December, 1949, several collections of ripe guavas, *Psidium Guajava* L., gathered for the most part from the ground, were made at points well distributed over the greater part of Oahu. Within a day after collection, the *D. dorsalis* larvae were removed from the fruit, segregated into instars, and allowed to complete their development in papaya pulp medium. In this manner parasitization of the different larval groups (instars) at the time of collection, was obtained. A summary of the numbers of parasites reared from the different instars is given in Table 4. This summary is based on rearings from 52 collections, each of which produced both species of parasites. The parasites that emerged from the first instar groups represent parasitization due to attack of only first instar larvae, those that emerged from the second represent parasitization of the first and second instars, and emergence from the third represents parasitization due to attack in all three stages. It is obvious that such figures do not show the maximum parasitization expected in the different stages in the field. From the information given in Table 4, from additional data on parasitization from other collections and from observations of adult behavior, there is considerable evidence that *O. persulcatus* commonly oviposits in younger larvae than those normally attacked by *O. longicaudatus*. The ratios of *O. persulcatus* to *O. longicaudatus* in the different instars obtained from the data in Table 4 are as follows: first instar, 16.0 to 1; second instar, 4.5 to 1; third instar, 2.2 to 1. Females of *O. longicaudatus* are commonly seen inserting their ovipositors in fruits on the ground, whereas adults of *O. persulcatus* apparently rarely occur on fruits on the ground. Furthermore, it can be seen from these figures that there was relatively little increase in parasitization by *O. persulcatus* in the later instars. On the contrary, there was an appreciable increase in the parasitization by *O. longicaudatus* in the larger larvae. There is the possibility that many young larvae stung by *O. longicaudatus* are killed and therefore that the species may actually attack a larger number of young larvae than the figures indicate. Despite this possibility, it now appears probable that *O. persulcatus* has a greater influence on first instar larvae than does *O. longicaudatus*.

SEX RATIO OF PARASITES

The available information indicates that more females than males occur in the populations of *O. persulcatus* and that the sexes occur in about equal numbers in the populations of *O. longicaudatus*. This condition prevailed in the shipments from Malaya as well as in the collections taken from the field on Oahu. In the imported collections, out of a total of 12,710[5] *O. persulcatus* received, females predominated 2.1 to 1, and in a total of 587 *O. longicaudatus*, females occurred at a ratio of 1.0 to 1. From the 52 Oahu collections referred to above, a total of 3,607 *O. persulcatus* and 1,213 *O. longicaudatus* were reared. The figures show that

[5] Figures obtained from records submitted by the Territorial Board of Agriculture and Forestry and the U. S. Bureau of Entomology and Plant Quarantine.

the ratio of females to males was 1.8 to 1 for *O. persulcatus* and 1.0 to 1 for *O. longicaudatus*. These ratios are quite similar to those obtained from the Malaya collections.

Table 5.—Sex ratio of O. persulcatus and O. longicaudatus reared from D. dorsalis larvae of different instars at the time of collection.

Instar	O. persulcatus		O. longicaudatus	
	No. reared	Ratio of females/males	No. reared	Ratio of females/males
1st	192	1.8	12	0.2
2nd	1,501	1.8	335	0.7
3rd	1,914	1.8	866	1.1
TOTAL	3,607	1.8	1,213	1.0

Table 5 shows the sex ratios of the parasites reared from the different instars of *D. dorsalis* larvae. The sex ratio of *O. persulcatus* was the same for the groups reared from all three host instars, whereas the ratio of females to males of *O. longicaudatus* increased with the later instars. The true sex ratio of *O. longicaudatus* that develop from larvae parasitized in the first instar may be quite different from that shown in Table 5 since relatively few individuals were reared. It would appear from the more favorable sex ratio of *O. longicaudatus* obtained from the third instar that this parasite is better adapted to development in older larvae. Furthermore, the favorable sex ratio of *O. persulcatus* reared from all three instars indicates that it is well adapted for development in the smaller larvae.

DISCUSSION

Sufficient time has not elapsed to determine what the final status of *O. persulcatus* and *O. longicaudatus* will be in Hawaii, or what relation the species will have to each other. However, both parasites have become well established and give promise of playing an important role in reducing the abundance of *D. dorsalis* in the Islands. During the late summer and fall of 1949 *O. persulcatus* increased tremendously in abundance and by the end of the year had become far more numerous than *O. longicaudatus* in several localities. Since *O. persulcatus* is the predominant species in Malaya and there has been a shift in that direction recently in Hawaii, it may possibly become the more important of the two species here.

The Hybridization of Aedes aegypti and Aedes albopictus in Hawaii

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(Presented at the meeting of December 12, 1949)

In the Territory of Hawaii, there are three species of mosquitoes: *Aedes albopictus* (Skuse), *Aedes aegypti* (Linn.), and *Culex quinquefasciatus* Say. Usinger (1944) has reviewed the biology of the two *Aedes* species in connection with an epidemic of dengue which occurred in Honolulu in 1943-44. Mention is made of various experiments in which the hybridization of these species had been tried. From time to time various authors have reported attempts to cross different species of mosquitoes. In only a few of these attempts has success been reported. Weyer (1936) and Roubaud (1941) successfully crossed *Culex pipiens* with *Culex quinquefasciatus* in Europe. Various workers have reported hybridization experiments in species and varieties of anopheline mosquitoes (cf. Corradetti, 1934, 1937A, 1937B; de Buck, *et al.*, 1934, 1937; Roubaud, *et al.*, 1936, 1937; Diemer and Van Thiel, 1936; Sweet, *et al.*, 1938; Bates, 1939). Toumanoff (1937, 1938, 1939) reported successful crossing in Indo-China between *Aedes aegypti* and *Aedes albopictus* while cross-breeding experiments with material from Calcutta and Indo-China were unsuccessful (Toumanoff, 1937). Simmons, St. John and Reynolds (1930) were unsuccessful in crossing these species using material from the Philippines. Hoang-Tich-Try (1939) reported that male *A. aegypti* and female *A. albopictus* crossed readily in small cages and at unfavorable times of the year. In this report of successful crossing all the progeny resemble *A. albopictus* except in a single specimen. De Buck (1942) reports that he was unsuccessful in hybridizing laboratory strains of *A. aegypti* and *A. albopictus*, but microscopic examination of the spermatheca in the female of both species demonstrated the presence of spermatozoa. No embryonic development occurred in eggs laid by female *A. albopictus* and the few larvae that hatched from eggs laid by *A. aegypti* died in several hours. Downs and Baker (1949) reported success in crossing female *A. aegypti* and male *albopictus*, while the reciprocal cross failed. MacGilchrist (1913) observed in Calcutta "that individuals of the species *fasciatus* [*A. aegypti*] not infrequently copulated with individuals of the specie *scutellaris* [*A. albopictus*]; but this coupling seems to be unproductive." Connal (1925) attempted to cross-breed *A. aegypti* with *Aedes luteocephalus* and *Aedes longipalpus* in Africa but with negative results.

In the course of the mosquito control program sponsored by the Territorial Board of Health, the Honolulu Chamber of Commerce and the U. S. Public Health Service, a small laboratory was established. In addition to the regular work of the laboratory directly connected with

control activities, there was an opportunity to perform a few experiments on the hybridization of *A. aegypti* and *A. albopictus*.[1]

METHODS

Adult mosquitoes for this experiment were obtained by removing pupae from laboratory cultures of *A. aegypti* and *A. albopictus*. Each pupa was segregated in an individual cotton-stoppered vial. After the emergence of the mosquitoes, each was individually examined and separated into groups according to sex and species. Extreme care was observed and duplicate observations by two workers were made to insure accuracy. Male *A. albopictus* and female *A. aegypti* were introduced into one cage and male *A. aegypti* and female *A. albopictus* were introduced into another cage. These cages were supplied with moist raisins, sugar water and a growing plant (*Philodendron* sp.) as food for the mosquitoes. These cages were placed in a screened room and were each enclosed in a mosquito bar as an additional safeguard. From time to time at irregular intervals, human blood meals were provided and the vials examined for eggs. Two trials with male *A. aegypti* and female *A. albopictus* were unsuccessful since no fertile eggs were obtained. In the reciprocal cross with female *A. aegypti* and male *A. albopictus*, two out of three trials produced fertile eggs and living larvae. The larvae were removed and placed in covered containers and fed upon rice or bread crumbs. As the adults of the F_1 generation emerged, they were collected and examined to determine sex and species. In several cases the fourth instar larva or larval skins were mounted for microscopic examination. The male terminalia of some of the F_1 males were prepared and mounted on slides for comparison with terminalia of males of the two local *Aedes* species. In one experiment, the F_1 generation was placed in a cage and allowed to inter-breed and the offspring were also examined. This process of in-breeding was repeated for five generations as follows:

9/10/44—4 female *A. aegypti* and 8 male *A. albopictus* introduced into cage.
9/11/44—2 females took a blood meal.
9/14/44—1 female took a blood meal.
9/18/44—Larvae and eggs observed in a glass jar and a glass vial. Larvae removed to cloth-covered container and provided with rice.
9/30/44—1 male mosquito emerged.
10/ 3/44—12 adults emerged by this date, 4 females and 8 males.
10/ 6/44—4 females and 6 males emerged.
10/ 7/44—All specimens of the F_1 generation placed in a large breeding cage.
10/ 7/44—3 F_1 females took a blood meal.
10/ 9/44—First instar larvae present in the F_1 breeding cage.
10/17/44—First F_2 adults emerged.

[1] These experiments were, unknowingly and simultaneously, carried on at the same time that similar work was being done at the Rockefeller Foundation by Dr. Wilbur Downs and Rollin Baker. The results are mutually confirmatory which adds significance to these experiments.

10/17/44 to 11/12/44—Between these dates 182 males and 63 females had emerged.
10/23/44—A group of F_2 males and females were placed in a breeding cage.
11/10/44—46 males and 30 females of the F_2 generation had emerged.
11/13/44—10 males and 6 females of the F_2 generation were placed in a breeding cage.
11/25/44—18 males and 6 females produced in the F_4 generation.
12/20/44—3 males and 4 females secured in the F_2 generation.

Examination of all specimens obtained in this experiment has shown them to appear exactly like *A. aegypti*. There was no evidence of any modification of morphological structure that could be ascribed to the male *A. albopictus* parent. Examination of the terminalia of males in each of the several generations showed them to be identical with the terminalia of pure *A. aegypti* males. Examination of the larvae and pupae did not show any difference from normal *A. aegypti* larvae that could be detected. From the results of this experiment it can be concluded that fertile eggs can be produced from matings of female *A. aegypti* and male *A. albopictus*. The offspring resembled the maternal parent and showed no external morphological evidence of a paternal contribution. Unless the mechanism of sex determination is different from the condition found in other Diptera, parthenogenesis cannot account for these results since both sexes were obtained and they were fertile amongst themselves.

In order to determine the presence of a paternal contribution, the following back-cross experiment was performed with the females of the F_1 hybrid generation obtained in a hybridization experiment similar to that which has been described above. The F_1 females, which all had the markings of *A. aegypti*, were placed in a breeding cage with a large number of carefully identified and segregated male *A. albopictus*. A summary of the experiment is presented here:

12/21/44—5 female F_1 hybrids, resembling *A. aegypti*, were placed in a breeding cage with 22 selected male *A. albopictus*.
12/22/44—1 female took a blood meal. No copulation observed although several attempted copulations were noted.
12/27/44—An additional 20 male *A. albopictus* placed in the cage. Many attempted copulations but of short duration.
12/29/44—1 vial containing approximately 35 eggs removed from cage.
1/ 2/45—Many successful copulations observed. Two batches of eggs totaling 80 in vials removed from cage.
1/ 5/45—1 larva hatched from eggs removed on 1/2/45. Females took blood meal. Many successful copulations observed prior to and after blood meal.
1/12/45—Larva successfully pupated. Fourth instar skin mounted.
1/13/45—Adult male mosquito emerged from pupa. Appears as *A. albopictus*. 20 additional eggs removed from cage in vials.
1/21/45—2 female F_1 mosquitoes remained. 1 took a blood meal. 25 additional *A. albopictus* males added. 40 eggs removed from cage.

1/23/45—From the total of 175 eggs, only a single larva already mentioned was obtained. Attempts to induce hatching of the other eggs were unsuccessful.
1/26/45—No additional eggs obtained. Experiment discontinued.

An examination of the single specimen produced by back-crossing of females of the F_1 hybrid generation (*A. aegypti* × *A. albopictus*) showed the specimen to be indistinguishable from normal *A. albopictus* males. The fourth instar larval skin was identical in appearance to the normal larval skin of *A. albopictus*. An examination of the terminalia of this single male showed it to be exactly similar to the terminalia of a pure *A. albopictus* male. This specimen developed from eggs laid in a clean vial and there is no doubt but that these eggs were laid by the female hybrids. There can be no doubt concerning a true hybridization in the formation of the F_1 generation. Unfortunately neither equipment nor time was available to study the chromosome pictures in these specimens produced by these hybridization experiments. (cf. Sutton, 1942.)

From the control standpoint, it is of considerable interest that female *A. aegypti* can mate with male *A. albopictus* and produce fertile eggs. It is not known whether this can occur outside of the laboratory. There is, however, a possibility that in an area where the ranges of these mosquitoes overlap, such as in Hawaii or Asia, such an occurrence would possibly complicate aspects of control.

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The more important Insect Pests of Sugar Cane in Northern Venezuela

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(Presented by Mr. Pemberton at the meeting of September 12, 1949)

Sugar cane plantations have been established in the settled northern part of Venezuela at different periods since early Spanish colonial times, at least 300 years ago, and today sugar products count among the more important agricultural industries of the country. The growing of sugar cane is not centered in any one district, however, but the numerous *centrales* (factories producing refined sugar), *haciendas* (private estates), or *fincas* (small estates and farms), are scattered through practically every one of the nineteen Venezuelan states north of the Rio Orinoco.[1] At least 95 per cent of the sugar cane grown in Venezuela is more or less confined to a curved belt, approximately 120 kilometers wide, which follows close to the northern mountainous and hilly regions, and extends for ten degrees of longitude, from 62° W. (Monagas State) to 72° W. (Táchira State). The altitudinal range of the crop extends from sea-level to 1,800 meters, but most of the sugar cane is grown at elevations of from 200 to 500 meters. Within the above-mentioned belt, the actual areas under cane cultivation vary from small fincas of 1 or 2 hectares and estates of 20-100 hectares, to large plantations of 2,000 hectares or groups of haciendas covering more than 3,500 hectares. The most important sugar producing states in Venezuela are Sucre, Miranda, Guárico, Aragua, Carabobo, Yaracuy, Lara, Trujillo, Mérida, Táchira and Zulia.

It will at once be recognized that these numerous sugar cane areas, established at different times, and separated from one another by varying distances, and by terrain which varies in nature from coastal marsh, swamp forest, sandy desert, or open savannah, to high mountain ranges, can best be considered as forming an archipelago of ecological islands, each with its own more or less distinct history and characteristics of soil, climate and plant ecology. Under such conditions, it is not surprising that different species of insects have developed into pests of varying degrees of economic importance in different localities, and that one which is quite serious in one place may be a minor pest or even quite absent in others. A full discussion of the distribution and status of the numerous sugar cane insects of Venezuela, and their natural enemies, must be left for the future, and in the present paper the writer proposes to give a brief account of those species which are at the present time of economic importance in one or more localities.

[1] The *haciendas* and *fincas* produce the solid blocks and cones of excellent quality brown sugar known respectively as *panelas* and *papelones*, and sometimes raw and rectified spirit (rum), which is also produced in some of the *centrales*.

These investigations were begun by the writer in December, 1946, and are the result of work carried out in the Section of Sugar Cane Insects, Division of Entomology, of the Venezuelan Ministry of Agriculture. They have covered practically all of the principal sugar cane areas of the country, as shown in the map.[2]

Two outstanding features concerning the sugar cane insects of Venezuela are worthy of note. In the first place, these insects, without exception, are all indigenous in the country or have spread naturally from adjacent territories, none of them having been introduced from abroad. Secondly, one is struck by the number of insects which are pests in Venezuela, but not known as such in other countries. Since no comprehensive list has yet been published, it is hoped that the following preliminary account may be of interest.

Lepidoptera

PYRALIDAE

Diatraea saccharalis (Fabr.), **D. impersonatella** (Walk.), **D. canella** Hamps., **D. busckella busckella** Dyar & Heinr., **D. busckella rosa** Heinr. The Moth Borers.[3]

The life history and general type of damage caused by the larvae do not differ in essentials from the published accounts concerning the well-known *D. saccharalis* in other countries. The actual amount of damage done to individual cane-stalks by the larvae of *b. busckella* and *b. rosa*, however, is considerably greater than that done by *saccharalis*. The tunnels are larger and much longer, generally passing through several successive internodes. In terms of *Intensity*, i.e., percentage of the internodes showing external borer tunnels, the average annual *Diatraea* damage in Venezuela varies from about 5.0 per cent in the eastern states (Monagas and Sucre) to 27.5 per cent in the Tocuyo valley (Lara); in the latter district, individual estates are known with an average Intensity of 35.0 per cent, indicating a loss of more than 50 per cent of the potential sugar. Other heavily infested areas (Intensities of 16.0 per cent or more) are the upper Tuy and Aragua Valleys (Aragua), and the Turbio Valley (Yaracuy and Lara). In general terms, it may be stated that the average Intensity for the whole country is in the vicinity of 15.0 per cent, corresponding to a loss in sugar products valued in Venezuela at approximately U.S. $6,000,000 annually. The distribution and status of each of these moth borers has been studied in detail, and may be summarized as follows:

[3] The two maps accompanying this paper are the work of the writer's colleague, Signor Pietro Guagliumi.

[2] Full accounts of these moth borers in Venezuela have been given by the present writer in (i) "Informe Preliminar sobre los Taladradores de la Caña de Azúcar (*Diatraea* spp.) en Venezuela," Boletin Técnico (No. 1), Sección de la Caña de Azúcar, Departamento de Entomologia, Min. Agric., Caracas, December 1947, pp. 1-117, pls. i-xix; and (ii) "Investigaciones sobre los Taladradores de la Caña de Azúcar (*Diatraea* spp.) en Venezuela. Informe del Progreso durante 1948-1949," Bol. Tec. No. 2, idem., pp. 1-60, 1 graph and 1 map in text, with folding map. (In course of publication.)

Diatraea saccharalis (Fabr.)

One of the most important species, occurring throughout the country, and in the majority of the cane-growing areas. It is, however, relatively scarce in the eastern states (Monagas and Sucre), and has not been found in sugar cane (though it occurs in corn and wild grasses) in the extensive plantations of Central Tacarigua (alt. 430 meters) and Central Lucinda, Urama (near sea-level), both in Carabobo State. In both of these areas *D. b. rosa* is the dominant cane borer. Our records show *saccharalis* to be absent from the numerous scattered cane areas in Trujillo State, in the eastern Andean region (300-1650 meters), where the dominant borer is *D. b. busckella*. The areas where *saccharalis* is most abundant and destructive are the following: Altagracia del Orituco (Guárico, 350-400 meters); Guatire-Guarenas (Miranda, 320-380 meters); the middle and upper Rio Tuy valleys (Miranda and Aragua, 180-550 meters); the Aragua valley and tributaries (Aragua, 450-500 meters); Central Matilde, Chivacoa (Yaracuy, 225 meters); the Rio Turbio and Rio Tocuyo valleys (Lara, 350-450 meters and 600-750 meters, respectively). In the Andean region, *saccharalis* occurs sparsely in sugar cane around Mérida (1300-1650 meters) and Egido (1100-1250 meters), and also in the vicinity of San Cristóbal and Rubio (800 meters) in Táchira State.

Diatraea impersonatella (Walk.)

The distribution of this borer in Venezuela is rather curious. The species is actually known to occur from Sucre State to as far west as Trujillo, and also on the llanos (Apure and Portuguesa), and the larvae are not uncommon locally in certain wild species of *Paspalum*, principally *P. virgatum* and *P. fasciculatum*. In sugar cane, however, *impersonatella* has been found only at Cumanacoa (230 meters) and Cumaná (sea-level) in Sucre State, and at El Tocuyo (600-750 meters) in Lara. At El Tocuyo, this borer, in company with *canella, saccharalis* and *b. busckella,* is quite a serious pest, attacking canes of all ages from the youngest shoots to stalks ready for harvest. When it is remembered that *impersonatella* is the most important cane borer in the neighboring island of Trinidad, it will be realized that it requires careful watching, because it may be in process of gradually adapting itself to sugar cane in new localities in Venezuela.

Diatraea canella Hampson

This species is almost as widely distributed as *saccharalis,* but rather more scattered. It is abundant at Altagracia del Orituco (Guárico, 300-400 meters), Guatire-Guarenas (Miranda, 320-380 meters), the upper Tuy Valley (Aragua, 500 meters), the Aragua valleys (Aragua, 450-500 meters), Central Tacarigua (Carabobo, 430 meters), the Rio Turbio and Rio Tocuyo valleys (Lara, 350-400 and 600-750 meters), and San Cristobal-Rubio (Táchira, 800 meters). The discovery of this species in the far west of Venezuela is of special interest, since previously it was believed to be limited to the eastern and east-central states. Although the larva is much larger than that of *saccharalis,* it is not generally reck-

oned so destructive, owing to its preference for young unjointed shoots (especially ratoons) rather than mature stalks. Occasionally, however, it damages the latter, causing them to die, and in such cases the damage may be serious where the insect is abundant.

Diatraea busckella busckella Dyar & Heinr., and
Diatraea busckella rosa Heinr.[4]

D. busckella may be counted among the most destructive sugar cane insects of Venezuela, and one or the other of the two subspecies is now known to occur in practically every cane-growing area of the country. Owing to the large size of the larvae (which average from 1.5 to 2.0 times those of *saccharalis*), and their abundance, the damage caused by this species can be particularly severe in certain localities.

Of considerable zoological interest is the geographical distribution of the two subspecies. The species itself (as here recognized, but see foot-note 4) ranges through northern South America for a distance of more than 2000 kilometers from eastern Venezuela (it is not known in Trinidad or British Guiana) to the Isthmus of Panamá, i.e., from long. 62° W. to long. 80° W. *D. b. rosa* occupies the eastern part of this range, and *D. b. busckella* the western part, and the ranges of the two subspecies approach each other, without overlapping, and almost meet in Yaracuy State. The most easterly points in the range of *b. busckella* are Chivacoa and San Pablo, situated less than 20 kilometers from farms in the upper Rio Nirgua valley, where *b. rosa* reaches its most westerly limit in this region. As stated above, there appears to be no overlapping in the respective zones of distribution of these two subspecies, and nowhere have they both been found together, in spite of very thorough search in the critical ecotone. Of special practical importance, therefore, are measures to prevent the accidental introduction of one or the other of these destructive borers into an area where at present it does not exist.

A glance at the two maps accompanying this paper will suggest that the zones of distribution of *b. busckella* and *b. rosa* are more or less coincident with the two main systems of mountain ranges. Nevertheless, our surveys indicate no ecological barriers of sufficient importance to explain the abundance of one of the subspecies at Chivacoa and the other less than 20 kilometers away. This investigation is proceeding, and will form the subject of a special paper to be published at a later date.

Parasites[5]

The above species of *Diatraea,* whose larvae are normally sugar cane borers, are attacked by a considerable number of parasites, the majority of which have not previously been reported from Venezuela. The most

[4] *D. b. rosa* Heinr. was originally described as *D. busckella* var. *rosa* Heinr. 1931 (Proc. U. S. Nat. Mus. 79, no. 2879:4); recently it was made a subspecies by the present writer (Bol. Entom. Venez., 7:39, Caracas, 1948). Further work is leading us to regard *busckella* and *rosa* as separate species, but until this is complete it is preferred to retain their present status as subspecies.

[5] For the determination of the dipterous parasites the writer is greatly indebted to Dr. F. I. van Emden, and of the Hymenoptera to Messrs. G. E. Nixon and G. J. Kerrich; the identity of the signiphorid hyperparasite was confirmed by Dr. A. B. Gahan.

important of them is the dexiine, *Paratheresia claripalpis* (Wulp), which occurs throughout the country parasitizing the various species of *Diatraea* in degrees which vary according to the locality and food-plant; it appears to be most effective, however, as a parasite of *Diatraea lineolata* (Walk.), the widely distributed corn borer. Among the cane borers its preferred hosts are *saccharalis, b. rosa,* and *b. busckella,* and in some localities the first-named seems to be kept well under control by it. It is attacked by four distinct hymenopterous hyperparasites, among which the signiphorid, *Thysanus dipterophaga* (Gir.) is the most frequently met with. Other Diptera attacking cane borers in Venezuela are *Leskiopalpus diadema* (Wied.), *Sarcodexia sternodontis* (Towns.), *Zenillia palpalis* Aldr. (extremely rare), and a tachinid, which Dr. van Emden provisionally considers to be close to *Zenillia ochracea* Wulp, which is very local and rare. Among the Hymenoptera, the egg-parasite, *Trichogramma evanescens* Westw. (*T. minutum* Riley) is ubiquitous; other egg-parasites are *Prophanurus alecto* Crawf. and *Telenomus* sp., both extremely local. Hymenopterous parasites of the larvae include five species of *Ipobracon* and four species of *Microdus* (*Bassus*), among which *I. grenadensis* Ashm., *M.* (*B.*) *stigmaterus* Cress., *M.* (*B.*) *sacchari* Myers, and *M.* (*B.*) sp., are the most frequent. The pupal parasite, *Spilochalcis dux* (Walk.), is rare as a parasite of *Diatraea* in sugar cane, but occasionally common in corn and certain wild grasses. Four distinct species of fungi attack the cane borers, but only one of them, *Cordyceps barberi* (Giard), is at all common.

CASTNIIDAE

Castnia licoides Boisd. (**C. licus** Dru.). Giant Moth Borer.

This is a serious pest of sugar cane in British Guiana and Trinidad, but is extremely localized in Venezuela. Its history, however, suggests that *C. licoides* may only be beginning its attacks, and therefore the insect is to be regarded as being of considerable potential importance.

At present, we have found the larvae abundant only at two localities in Carabobo State, viz., Central Tacarigua and Bejuma, 30 kilometers farther west, but in neither place can their importance be compared with the attacks commonly met with in Trinidad and British Guiana. Larvae of a *Castnia* sp., at present unidentified, but perhaps *C. licoides,* have been found in sugar cane and bananas around San Cristobal (Táchira), and information has been received concerning an attack of *Castnia* in sugar cane at Upata, south of the Rio Orinoco and 120 kilometers east of Ciudad Bolivar.

No natural enemies of *Castnia* have so far been discovered in Venezuela, but it is worth mentioning that the tachinid, *Zenillia palpalis* Aldr., recorded above as a parasite of *Diatraea,* was originally described from specimens reared from *C. licoides* larvae in *Heliconia Bihai* L. (Musaceae), in the Northwest District of British Guiana, by the late Dr. J. G. Myers (Aldrich 1932, Proc. U. S. Nat. Mus. 81, 9:19).

Coleoptera

SCARABAEIDAE

Unlike the Antillean region, Venezuela is singularly free from the attacks of white grubs, e.g. *Lachnosterna* (*Phyllophaga*), *Ligyrus,* etc., in the cane fields. Adults of several species of *Lachnosterna* are sometimes very abundant around the sugar estates, but the larvae of none of them can be considered as pests. The only scarabaeid which comes into this category is the following:

Podischnus agenor (Oliv.). Rhinoceros Beetle.

This dynastid has been very thoroughly investigated and its biology studied by Signor Pietro Guagliumi, whose results are shortly to be published by the Venezuelan Ministry of Agriculture. The general nature of the insect and its damage were described and illustrated by F. A. Bianchi in 1935 (Hawaiian Planters' Rec. 39:191-197), who studied it in Guatemala.

P. agenor has been found at numerous localities scattered throughout northern Venezuela from Sucre State in the east to Táchira in the west. A related species, *P. horni* Sternb. (determined by Dr. E. A. Chapin) has been collected on a sugar estate at San Cristobal (Táchira), but its exact status is not yet known.

The maximum destructiveness of *P. agenor* has been observed in certain fields at Central Tacarigua (Carabobo), where the damage is sometimes quite spectacular. The insect appears recently to have become established in the important cane zones of the Turbio and Tocuyo valleys (Lara).

Signor Guagliumi has shown that the larvae normally live only in soils over-rich in decomposed or semi-decomposed vegetable matter, and that they feed on the soil humus, rarely if ever eating living plant tissues. The damage is done by the adult beetles, which appear in large numbers at the commencement of the rainy season (April-May), and eat their way into the cane stalks, excavating large tunnels and causing their death.

The only parasite so far discovered is the larva of a large black scoliid wasp, which has been determined by Dr. J. Chester Bradley as *Campsomeris servillei* (Guer.) (syn. *C. hyalina* Sauss.). This is a widely distributed species known, according to Bradley (Bol. Ent. Venez., 4:33, Caracas, 1945), from Guatemala, Costa Rica, Panama, Venezuela, Trinidad, Dutch and French Guiana, Brazil, Argentina (Misiones), Paraguay, Peru, Bolivia west to the coast, and Chile (Arica). In Venezuela it is recorded from Monagas State in the east to Merida in the west.

CURCULIONIDAE

Metamasius hemipterus (L.). Weevil Borer.

The common neotropical weevil borer, *M. hemipterus,* has been found in nearly every sugar cane area, its attacks nearly always following on those of *Diatraea.* Occasionally, however, its damage may be quite serious, for which reason it is included here.

Hemiptera-Homoptera

This group of insects includes a large number of species directly associated with the sugar cane in Venezuela, but comparatively few of them can be ranked as major pests.

COCCIDAE

Trionymus sacchari (Ckll.). Pink Mealybug.

One of the most widely distributed pests of sugar cane in Venezuela, which may occasionally be very severe, especially during the dry season in small isolated farms where the fields have been generally neglected. The writer has seen in Venezuela extremely severe attacks of sugar cane mealybugs in some districts, but always on a small localized scale; such outbreaks are always accompanied by vast numbers of ants. On the larger estates and plantations this pest appears to be adequately controlled by native predators, among which the coccinellid, *Hyperaspis trilineata* Muls. (det. Dr. E. A. Chapin), appears to be the most important.

APHIDAE

Sipha flava Forbes. Yellow Sugar Cane Aphis.

Another insect which is widely distributed but only occasionally severe. The worst attacks are in fields of young plant canes, the development of which may sometimes be seriously impeded. These outbreaks appear to be associated with generally poor agricultural conditions, and heavily attacked fields also show the symptoms of various root-diseases, especially *Sclerotium Rolfsii* Sacc.

Common predators are coccinellid larvae, notably *Cycloneda sanguinea* (L.) and *Coleomegilla maculata* (Dej.), and the larvae of lacewing flies (*Chrysopa*).

Aphis maidis Fitch. Corn Aphis.

Because of the widespread abundance of the mosaic disease in Venezuelan cane fields, its well-known vector, *Aphis maidis*, should be included in any list of the sugar cane insects of the country. It is to be admitted, however, that the insect appears to be very rarely seen on sugar cane, and has been observed by the writer on very few occasions.

JASSIDAE

Rhopalogonia scita (Walk.). Spotted Leafhopper. (Det. by J. W. Evans.)

This insect appears to be unknown as a pest except in Venezuela, whence it was originally described. It has been found at numerous localities in Miranda, Guárico and Aragua States, and also in the Andean region. Severe outbreaks seem to occur only in the more elevated regions (approximately 1000 meters and upwards), and in such cases the insects literally swarm in the cane fields, their numerous feeding punctures causing the foliage to turn brown and wither. Such outbreaks were observed in the dry season (January-March) of 1947, in the Rio

Guaire valley (Miranda, 960 meters), a few miles west of Caracas, and at La Puerta, in the eastern Andes (Trujillo, 1500-1650 meters).

All stages are passed on the leaves of sugar cane, corn and certain wild grasses. The biology has been studied and our observations will shortly be published.

DELPHACIDAE

Saccharosydne saccharivora (Westw.). Green Leafhopper. (Det. by R. G. Fennah.)

This leafhopper, which in the old days in the West Indies earned itself the name of the "Blast," because of its destructiveness, has not received the attention that it merits in Venezuela, where occasionally it may be extremely abundant. Although heavy outbreaks appear annually at Central Tacarigua (Carabobo, 430 meters) and a few other localities, our observations suggest that the material damage is not serious, since the pest rapidly disappears and the plants soon recover from the attack. It must be conceded, however, that such outbreaks are at least spectacular, because practically every leaf of every cane plant harbors colonies of the insects, whose secretions fall to the leaves below, engendering a thick growth of sooty mould. The contrast in the appearance of the white waxy secretions of the insects and the black fungus, is very striking.

We have not been able to make a detailed study of this pest as yet, but we have observed and been impressed by the large number of its predators, notably coccinellid and chrysopid larvae, which appear very effective in reducing the numbers in succeeding generations. A high percentage of the nymphs and adults is stylopized.

CERCOPIDAE

This family includes the sugar cane froghoppers, among which the most well-known are those of Trinidad and British Guiana, hitherto known as *Tomaspis saccharina* Dist. and *T. flavilatera* Urich, respectively. In Venezuela, it would appear that certain related species have quite recently (since 1942) developed as major pests, and in truth, today the sugar cane froghoppers are considered second only to *Diatraea* in order of economic importance in this country. In certain districts, the insects appear in the form of annual outbreaks, causing damage at least as serious as that caused by the froghopper in Trinidad. The fields so attacked have the appearance of having been burned, for which reason the attacks are described in the vernacular under the name of "candelilla" (i.e., little fire). The outbreaks are now, however, regularly controlled by the application of insecticides. This work is in charge of Dr. H. C. James, Entomologist in the Sugar Cane Division, Ministry of Agriculture.

During 1946, 1947 and 1948 the present writer and his colleagues made large collections of froghoppers from sugar cane, corn and numerous wild grass hosts, wherever they could be found, this survey covering nearly all of the main sugar cane areas of the country. The resulting collection was submitted to the Commonwealth Institute of Entomology

in London, in July 1948, and we are fortunate that R. G. Fennah, the recognized authority on neotropical Homoptera, happened to be in England at the time. As a result of his examination of this material, together with the fine collection in the British Museum (which includes many types), Mr. Fennah published (Ann. Mag. Nat. Hist. [12] 1:605-620, 1948) a revision of part of the genus previously known comprehensively as *Tomaspis* A. & S., creating seven new genera, and restricting the majority of the economic froghoppers of Trinidad, British Guiana and Venezuela to *Aeneolamia* Fenn. Within this new genus, he recognizes six *Rassenkreise*, among which two, viz. *Ae. varia* (Fabr.) and *Ae. flavilatera* (Urich), include most of the economic froghoppers of Venezuela. The others are included in *Delassor* Fenn. Before the present paper appears in print, Mr. Fennah will have published his second report, in which he defines the various subspecies listed below.

Aeneolamia varia semifascia (Walk.), **Ae. v. campestris** Fenn., **Ae. v. costata** Fenn., **Ae. v. fallax** Fenn., **Ae. v. pallidior** Fenn., **Ae. v. paspali** Fenn., **Ae. v. tomentosa** Fenn., **Ae. v. sontica** Fenn., **Ae. flavilatera** ssp., and **Delassor tristis monagasi** Fenn. Sugar Cane Froghoppers.

The regional and local distribution of each of the above, together with several others taken from outbreaks on corn, or on wild grasses (and therefore to be regarded potentially as cane pests) are given by Mr. Fennah in his second report. For the purposes of the present paper, therefore, it is sufficient to state that the most widely distributed and economically serious form in Venezuela, at the present time, is *Ae. v. sontica* Fenn., which causes severe annual outbreaks of the "candelilla" in certain fields at Central Tacarigua (Carabobo), and especially on several estates in the Rio Turbio Valley (Yaracuy and Lara) centered around Yaritagua and Barquisimeto. This is the form which has generally been known as *Tomaspis bodkini* Williams, in Venezuela.

At times, any one of the other forms named above may be sufficiently abundant to rank as an important cane pest locally, for which reason the list includes all the froghoppers at present known to attack sugar cane in Venezuela.

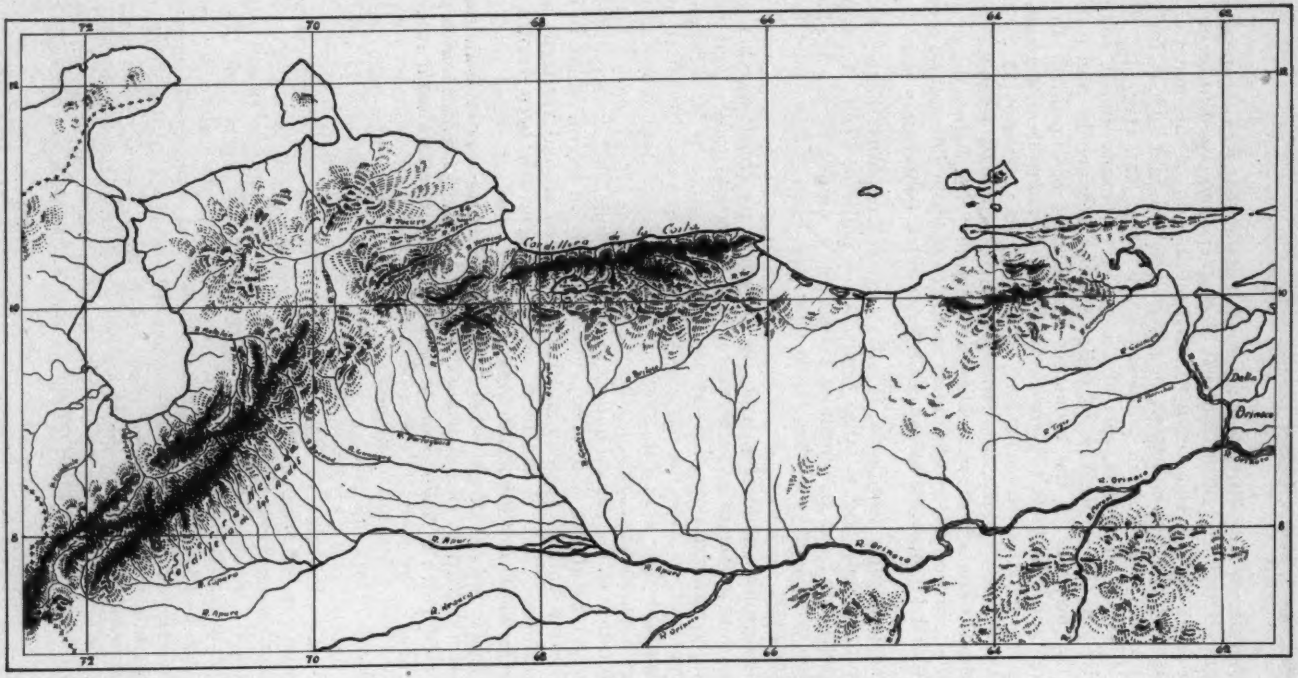

Figure 1.—Map of Northern Venezuela, showing principal physical features.

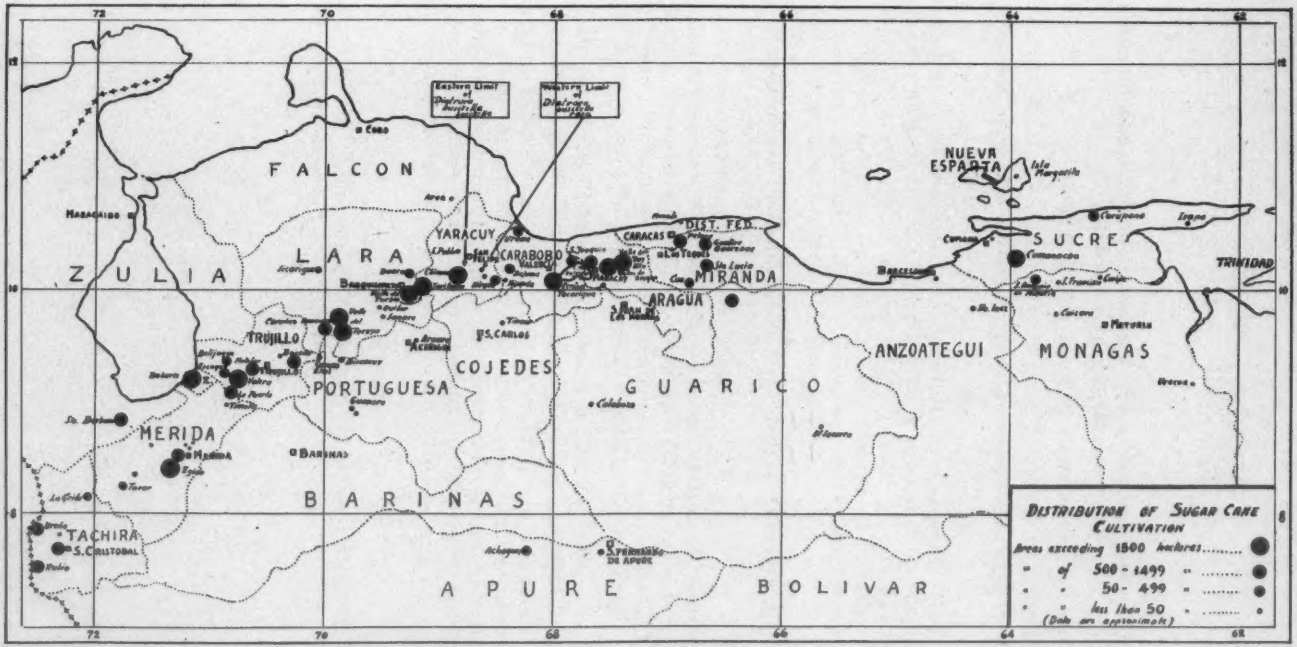

Figure 2.—Map of Northern Venezuela, showing the sugar cane areas.

Hermatobates haddonii Carpenter from the Marquesas Islands (Hemiptera: Gerridae)

By W. E. CHINA and R. L. USINGER

BRITISH MUSEUM (NATURAL HISTORY) AND UNIVERSITY OF CALIFORNIA

(Presented by Mr. Van Zwaluwenburg at the meeting of December 12, 1949)

The genus *Hermatobates* was described by Carpenter (1891) from specimens collected by A. C. Haddon on a coral reef on the Island of Mabuiag, Torres Straits. It was later (1901) made the type of a new subfamily, Hermatobatinae, by Coutière and Martin. The rather complicated synonymy and distribution of this most remarkable group of marine gerrids is summarized by Esaki (1947) as follows:

1. **Hermatobates haddonii** Carpenter (1891) =*Hermatobatodes marchei* Coutière et Martin (1901)
   = *Hermatobates* sp. Esaki, 1935

   Locality records: Mabuiag, Torres Straits (Haddon); Guichen Reef, nr. Troughton Island, W. Australia (Walker); Honda Bay, Palawan, Philippine Islands (Marche); Ishigaki Island, Yaeyama Group, Ryukyu Islands (Ikeda); New Caledonia (Esaki).

2. **Hermatobates djiboutensis** Coutière et Martin (1901)
   Locality record: Djibouti, Red Sea (Coutière et Martin)

Judging from the above records *H. haddonii* is widespread in the southern and western Pacific. We can now extend the known range considerably on the basis of a single specimen collected at Tahuata in the Marquesas Islands by Miss Evelyn Cheesman during the St. George Expedition visit to the Island, January 10th-13th, 1925.

REFERENCE

Esaki, T. 1947. Notes on *Hermatobates haddonii* Carpenter. Mushi, Vol. 18, pars. 7:49-51.

Field Studies on the Parasites of Brontispa mariana Spaeth[1]

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(Presented by Mr. Van Zwaluwenburg at the meeting of April 11, 1949)

Field studies on the imported parasites of the Mariana coconut beetle, *Brontispa mariana* Spaeth, were conducted in the Mariana Islands from July to November 1948. This work was undertaken to determine the successful establishment of the parasites and to measure their effectiveness in controlling the host.

Investigations were confined to the areas where initial parasite liberations had been made. These included seven localities on Saipan and all the coconut plantings of any appreciable size on the island. On Rota the field work was confined to a single locality on the southeast portion of the island.

Sampling of the host population in a coconut tree was accomplished by tying together the young, center, unexpanded fronds; severing them at the base; lowering them gently to the ground; and then removing all of the pupae that could be found through close inspection. The host pupae were held in vials for 6 days, or until the parasitized material could be easily recognized and segregated. This method of obtaining samples was also used successfully on the egg and larval stages of the host.

The first samples showed that the larval-pupal parasite, *Tetrastichus brontispae* (Ferrière), (figure 1), was well established. However, the egg parasite, *Haeckeliania brontispae* Ferrière, was not recovered and apparently was unable to maintain itself in the Mariana Islands.

Trees in which original parasite colonizations were known to have been made were avoided in the sampling. It was thus evident that the parasite, *Tetrastichus brontispae,* had undergone some natural dispersion in each locality.

In order to measure the activities of the parasites over a definite period of time, the sampling conducted in July was repeated in October. The comparison was made by combining the data from seven sampling stations, and then compiling the two series into table 1. From these data it appeared that *T. brontispae* was increasing its effectiveness in controlling the Mariana coconut beetle during the period from July to November. This was considered encouraging in view of the fact that the months under consideration were quite rainy and characterized by weather conditions generally unfavorable to optimum parasite activities. In November

[1] A project undertaken by the Pacific Science Board, Insect Control Committee for Micronesia, at the request of the United States Navy. Collecting was done on a survey made under the auspices of the Insect Control Committee for Micronesia of the Pacific Science Board, National Research Council, with financial assistance from the Office of Naval Research.

[2] On loan to Pacific Science Board as Field Associate in Entomology, 15 July 1948 to 15 January 1949.

a sample was taken on the island of Rota which indicated 75 per cent parasitism of the beetle pupae by *Tetrastichus*, however, the sample was too small to be considered as a reliable index of the parasite activities. This sample was taken only to determine that the establishment was successful on Rota.

Tetrastichus brontispae attacks both the larval and pupal stages of *Brontispa mariana*. The parasitized beetle larvae usually pupate before succumbing to their internal, gregarious parasites. Although emphasis in field sampling was placed upon the pupal stage of *Brontispa*, it was felt desirable to investigate the status of *Tetrastichus* on the larval stage of its host. The data from this investigation are compiled in table 2.

Table 1.—Field Parasitism of *Brontispa* Pupae—Saipan

Series	No. Pupae	No. Parasitized	No.[a] Dead	Per Cent Parasitized	Per Cent Dead	Per Cent Maturing
July 1948	389	130	35	31.3	9.0	59.7
Oct. 1948	367	222	33	60.4	8.9	30.7

[a] In each sample several pupae died from undetermined causes. This was found to be a rather constant factor at about 9 per cent. The author chooses to term it normal mortality. It occurred at the same level in areas where the parasites were not present.

Table 2.—Field Parasitism of *Brontispa* Larvae—Saipan

Locality	Date	No. Larvae	No. Parasitized	Per Cent Parasitism	Per Cent Pupal Parasitism Same Tree
Aslito (Finasisu)	Oct. 25	33	1	3.0	2.4
Canat i Etdot	Oct. 26	7	2	28.5	36.2
Chalan Kiya	Oct. 27	15	8	53.3	72.6
Magicienne Bay	Oct. 26	22	17	77.2	89.6

From these data it is evident that most of the beetle pupae found parasitized in the field were attacked by *Tetrastichus* while in the larval stage. The fact that *Tetrastichus* also attacks the pupae increases the effectiveness of the parasite and the vulnerability of the host.

At Magicienne Bay, Saipan, where parasite activity was particularly high (larvae 77 per cent, pupae 89 per cent), a number of larvae were found to be parasitized and to die before pupating. Quite a number of these did not produce adult parasites although dissections revealed the body cavity to be filled with larval *Tetrastichus*. These killed larvae constituted 13 per cent of the total host sample, and would be completely overlooked by the normal sampling procedure. The fact that this mortality results from the attack of *Tetrastichus* suggests an even greater degree of parasite effectiveness than is reflected in data taken solely from the pupae.

Field studies revealed that *T. brontispae* possesses several attributes which often characterize an efficient natural enemy:[a] (1) The life cycle is relatively short, and in the Mariana Islands there are two generations

of the parasite to each single generation of the host. (2) The parasite prefers to occupy the same area of the palm tree inhabited by *Brontispa.* (3) The power of dispersion of the parasite seems to be at least equal to that of the beetle. (4) Both larval and pupal stages of the host are attacked by the parasites. (5) *T. brontispae* is able to maintain its effective activity during the wet season. (6) The parasite is gregarious, and since each single brood usually consists of both sexes the conditions are favorable for mating and for producing an optimum sex ratio.

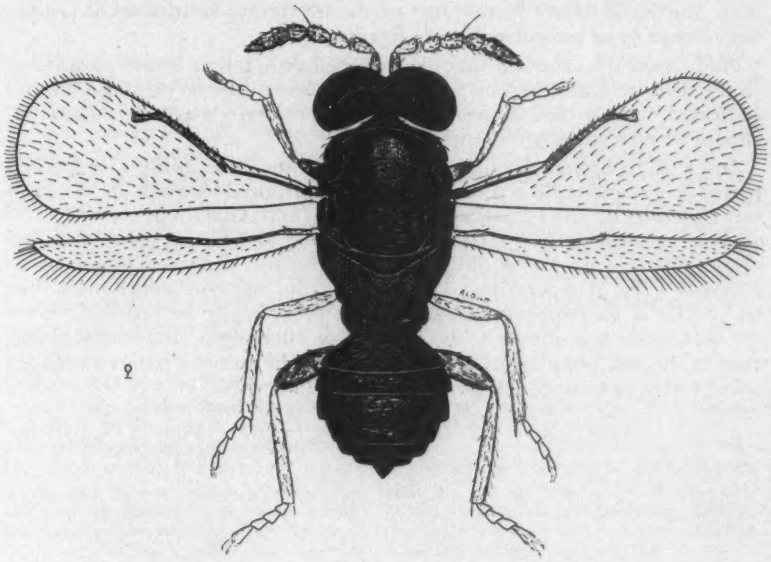


Figure 1.—*Tetrastichus brontispae* (Ferrière). Female, greatly enlarged.

In order to hasten the spread of the parasites and to effect their establishment in new localities, 5425 adult *Tetrastichus* reared from field collected material were distributed throughout the coconut plantings on the islands of Saipan, Rota, and Anatahan from August to December 1948.

Observations on infestations of *Brontispa mariana,* both in the Caroline Islands and in the Mariana Islands, indicated that the beetle attack must be severe and sustained to be lethal to the coconut palm. It appears that the tremendous recuperative power of the tree will overcome the pest if the beetle population can be reduced periodically by some agent. From the field data presented herein it seems that *Tetrastichus* is able to effect a substantial reduction in the host population. It is quite possible that this suppression of the coconut beetles may be sufficient to permit the coconut palms on Saipan to recover and grow in a normal manner.

Summary: Field investigations on parasites of the Mariana coconut beetle, *Brontispa mariana* Spaeth, disclosed that the larval-pupal parasite, *Tetrastichus brontispae* (Ferrière), was well established on the islands of Rota and Saipan but that the egg parasite, *Haeckeliania brontispae* Ferrière, had failed to maintain itself.

Field studies also indicated that parasitism by *T. brontispae* increased from a mean percentage of 31.3 in July 1948 to 60.4 per cent by the first of November. Furthermore, this increase occurred during a period of months having weather conditions generally unfavorable to parasite activities. On Rota Island 75 per cent of the beetle pupae in a small sample were found to be parasitized by *T. brontispae.*

Additional data showed that most of the beetle pupae found parasitized in the field were attacked by *Tetrastichus* while in the larval stage. Studies indicated further that *T. brontispae* possesses many attributes characteristic of an effective natural enemy.

In order to hasten the spread of the parasites, 5425 adult *Tetrastichus* reared from field collected material were distributed throughout the coconut plantings on the islands of Saipan, Rota, and Anatahan.

Observations in the Mariana and Caroline Islands suggested that the coconut palms are killed only after a severe and sustained attack by *B. mariana.* The recuperative power of the palm will apparently overcome the beetle if its populations can at least periodically be reduced. Since *T. brontispae* was shown to be capable of effecting a substantial reduction in the pest population, it is possible that the coconut palms on Saipan will be able to recover and grow in a normal manner.

A new Sub-species of Lallemandana fenestrata (F.) (Homoptera: Cercopidae)

By L. J. DUMBLETON

ENTOMOLOGICAL RESEARCH STATION, NELSON, N. Z.

(Presented by Mr. Pemberton at the meeting of December 12, 1949)

The interesting complex of species or sub-species of the genus *Lallemandana* has been studied by China (1935) who recognizes 10 sub-species of the typical form *L. fenestrata fenestrata* (F.). These occur in Samoa, Tonga, Society Islands, Tuamotu, and Rapa. Lallemand (1944) has added another sub-species, *L. f. gambierana* Lall. from Taravai Island in the Gambier Archipelago. There are also two other species of *Lallemandana* recognized by China in Tahiti and an additional species, *L. crockeri* Van Duzee (1937), has been described from Raivavae Island in the Austral Islands. Except in Tahiti, where three species of *Lallemandana* and four sub-species of *L. fenestrata* occur, the remaining species are each known only from a single island. I am now able to add an additional sub-species from Rarotonga.

Lallemandana fenestrata rarotongae new sub-species.

Head wider between inner margins of eyes than length in median line, 19:15; distance between ocelli equal to distance between ocellus and eye.

Vertex wholly light yellowish with the exception of the narrowly black lateral margins and a small area between the eye and the posterior lateral angle of the head.

Pronotum with a median yellowish area extending the full length, widest anteriorly and with nearly straight margins laterally; lateral areas black, the boundary between black and yellow running from the inner posterior angle of the eye to just mesad of the anterior lateral angle of the scutellum. Scutellum yellow.

Tegmen black, process of the black area not reaching costal margin, pale costal area extending nearly to tip; no paler area on clavus or corium; posteriorly the pale costal marking may end at the nervure between 2nd and 3rd apical cells or may extend part way into the 3rd cell and both conditions may be present on a single specimen.

Male genitalia. Paramere slender, sinuate, narrowing to a point, no accessory tooth apically. Aedeagus bent at right angles at mid length, parallel-sided in dorsal view, base of aedeagus 4/5 as wide as length.

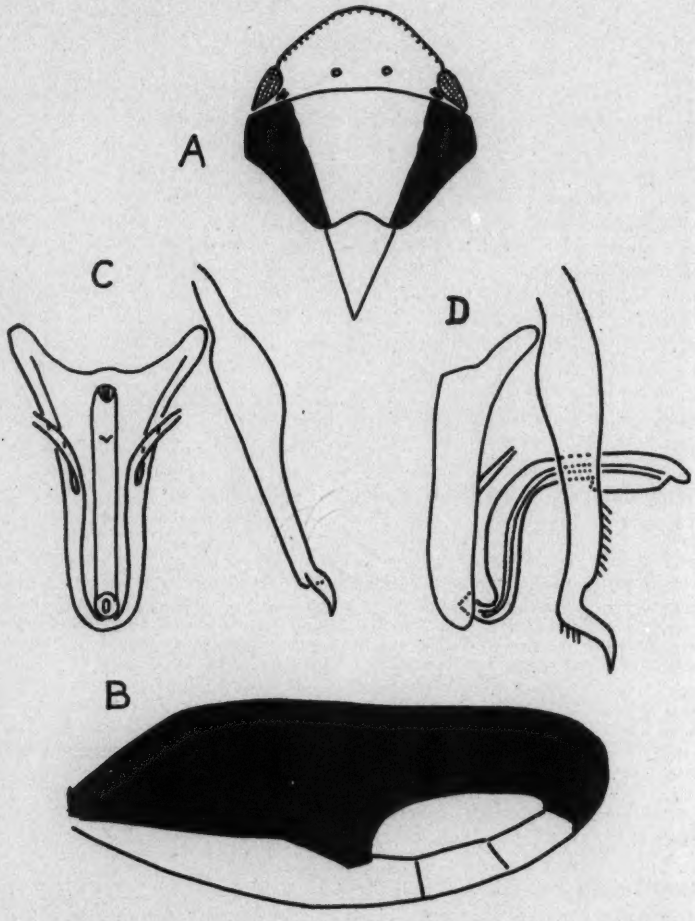
Length ♀♀ 9 mm. ♂♂ 7 mm.

Rarotonga, Cook Islands, July 1949. 5 ♂♂ and 4 ♀♀ on *Piper* sp.

Holotype ♂ and 8 paratypes (4 ♂♂, 4 ♀♀) in collection of Entomological Research Station, Nelson, N. Z. Paratypes, ♂ and ♀, in the collection of the B. P. Bishop Museum, Honolulu.

In colour pattern this new sub-species has the aspect of *L. f. interrupta* Lall. except that it lacks the median part of the black anterior pronotal band and the projection of the black area on the tegmen does not reach the costal margin. The paramere and aedeagus are similar in type

to that of *L. f. rapana* Lall. The new sub-species is quite distinct from any of the species related to *L. fenestrata* and from the described sub-species of *L. fenestrata.*



Lallemandana fenestrata rarotongae new sub-species

A. Head, pronotum and scutellum. Dorsal.
B. Tegmen.
C. Male genitalia. Dorsal.
D. Male genitalia. Lateral.

On the several occasions when I collected this insect it was invariably on a species of *Piper* (? *latifolia*) and the nymphs were also present on this food plant. *L. f. sociabilis* Lall. has been recorded on *Freycinetia* (one specimen only) and *L. f. gambierana* Lall. is recorded from *Hibiscus tiliaceus,* but it is not clear that these are the actual food plants.

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Description of a Brachymeria Parasitic on Agonoxena argaula Meyr. in Samoa

By D. T. FULLAWAY

(Presented at the meeting of July 11th, 1949)

Brachymeria agonoxenae n. sp.

Female 3.5 mm. long, black, tegulae, antennal scape, pedicel and club, fore and mid-legs ochraceous, hind femora reddish, hind tibiae with a yellowish band basally bordered by reddish brown, all the tarsi straw-colored with fuscous tips. Head as wide as or slightly wider than the thorax, transverse viewed from above, roughly triangular viewed from in front, more than twice as wide as long (anterior-posteriorly), wider than deep vertically, eyes convex, bulging, the fronto-vertex more than twice as wide as long (anterior-posteriorly) with ocelli in the middle arranged in an obtuse triangle, the lateral members wide apart but the front member only slightly further removed from lateral than it is from inner margin of eye; face moderately convex, clypeus impressed, front and hind margins angulate outlining a rhombus; antennae only moderately long (one-third body), more or less filamentous although increasing somewhat in thickness distally, inserted at lower level of eyes, scrobal impression fairly deep and smooth, wide below but narrowing above to less than one-half lower width, at middle distance occupies about one-third width of face and reaches almost to front ocellus, 13-segmented, scape elongate, one-half as long as flagellum, pedicel about one-fourth length of scape, ring joint small, transverse, less than half as long as wide, first flagellar segment nearly twice as long as wide at base, succeeding segments progressively shorter and slightly wider, 2nd, 3rd and 4th longer than wide, 5th quadrate, 6th and 7th wider than long, three segments comprising the club indistinctly separated, the last truncate instead of being rounded or pointed, all covered with an appressed pile; head umbilicately punctuate, the punctuations shallow and half a diameter apart, the intervening surface finely rugose, face and occiput clothed with silvery hairs. Dorsum of thorax to apex of scutellum convex, umbilicately punctuate, the punctuations on pronotum separated, those on mesonotum and scutellum more or less contiguous; pronotum well developed, parapsidal grooves on mesonotum complete but shallow, scutellum scutate with apical margin well-rounded and strongly carinate, a median depression immediately anterior to apex bounded by blunt projections representing incipient teeth, axillae distinct, far apart, metanotum depressed and followed by a deeply eroded transverse groove, propodeum convex, declivate behind, coarsely reticulate, propleura with shallow punctuations and a striate area dorsally, mesopleural sculpture coarser, the mesopleural sulcus wide and deep with shallow striations on fore-margin, metapleura coarsely reticulate like propodeum. Abdomen sub-sessile (2nd segment forming a broad pedicel), nearly as long as thorax, short ovate, apically pointed, convex above, flattened on the sides, which are sheath-like enclosing the ventrites, smooth, polished, 3rd segment occupying more than half the abdomen, following segments transverse and progressively shorter, tergites on 4th to 8th with transverse lines of shallow punctuations and silvery setae; ovipositor slightly exserted. Legs fairly long, front and mid-legs slender, hind pair stout; upper side of hind coxae flattened and smooth polished, hind femora a little longer than coxae and greatly swollen, width across outer face one-third length, six to seven teeth on lower edge, the basal one larger than the others, some of which are quite small; punctuation on legs rather fine. Wings hyaline, submarginal vein a little longer than marginal, postmarginal short, extending only slightly beyond the apex of marginal, stigmal also short and toothed at apex.

Male generally somewhat smaller than female and having antennae slightly shorter and thicker and hind femora concolorous with body instead of being reddish.

Described from seven specimens, three of which, one female (type) and two males (allotype and paratype) were collected in Samoa in July 1948 on *Agonoxena argaula* Meyrick by L. B. Loring; four others, two females and two males were reared Sept. 18-19th, 1948, on same host in the laboratory, Honolulu.

Type in the collection of the Hawaiian Entomological Society.

Superficially like *B. polynesialis* (Cameron), but an examination of the heads of the two chalcids discloses striking differences. The main difference is in the conformation of the face. The space between the scrobal impression and the inner margin of the eye is wider than in *polynesialis*, where it is only about one-sixth of the distance between the eyes, whereas in *agonoxenae* it is one-third.

Fruit Fly Parasites Collected in Queensland by N. L. H. Krauss in 1949 (Hymenoptera: Braconidae)

By D. T. FULLAWAY

(Presented at the meeting of December 12, 1949)

Amongst the fruit fly parasites sent in from Queensland, Australia, by N. L. H. Krauss, there have been found several which apparently represent undescribed species, in addition to others that are already well-known. The new species are described herewith.

Opius deeralensis n. sp.

Female. Length of body about 4.5 mm.; smooth and shining, finely clothed with silvery hairs; ochraceous, sparsely punctuate with microscopically fine setiferous punctuations, face closely beset; eyes, ocelli, ovipositor sheath, antennae (except the lower side of scape, apex of pedicel and base of 1st segment of flagellum, which are brown), and tips of mandibles and tarsi black or blackish.

Head transverse, nearly twice as wide as long, wide between the eyes, which are short oval and convex, ocelli near the middle of the vertex arranged in the form of an equilateral triangle and with a depression on the outer face which is margined, distance from lateral member to margin of eye three times that between centers of lateral members; antennae longer than the body, inserted not too close together (not much further removed from eye than from each other), the sockets deep with elevated rim, 45-segmented, scape and pedicel stout, the flagellum filamentous; face wider than long, more or less convex, clypeus distinct, anterior margin very obtusely angulate, hind margin curved to semicircular form; cheeks fairly wide, separated from face by clypeocular groove; mandibles stout, curved and apically toothed, base not nearly as wide as distance to eye along clypeocular line; maxillary palpi apparently 5-segmented, long, labial 3, short.

Thorax robust, half again as long as deep or wide and width equalling that of head, sides of the pronotum deeply sulcate, the groove costate on posterior face; mesothoracic scutum convex, with deep foveolate parapsidal furrows extending posteriorly from anterior lateral angles, converging and ultimately uniting at the head of a short median longitudinal groove which runs to the posterior margin; transverse prescutellar sulcus median and only two-thirds width of scutellum, costate and divided into four deep fossae, scutellum triangular, slightly convex on top, declivous at sides; metanotum depressed; propodeum convex, declivous behind, irregularly areolate, sculpture coarse for the most part, sides rather hairy along with the mesopleura, the latter with a costate groove anteriorly and a fairly large pitted fossa posteriorly at about middle depth; stigmata oval and small.

Abdomen ovate, somewhat compressed apically, the sides anteriorly collapsed, 1st tergite longitudinally striate, also longitudinally bicarinate medially, sides strongly margined as well, separated from following tergites, which are generally smooth and polished (anterior part 2nd faintly striate), by a deep sulcus; 1st and 2nd tergites with appressed silvery hairs, following ones with a transverse line of hairs close to posterior border; ovipositor exserted and like the antennae, longer than the entire body. Legs rather slender although the femora, especially the hind femora, are rather stout. Hind tibiae and tarsi blackish. Wings infumate, veins fuscous black, radius in anterior wing arising at middle of stigma, which is lanceolate; 2nd abscissa of radial vein twice as long as 1st and nearly as long as 1st cubital cross-vein, which is interstitial with the recurrent nervure; 2nd cubital cell wider than high, i.e., longer in the horizontal direction than in the vertical, although the 2nd abscissa of the cubital is half again as long as the 2nd abscissa of the radius and about equal in length to the 1st abscissa if not a little longer. Post-nervellus present in hind wings.

Male similar to the female except in the sexual characters.

Described from numerous specimens reared from *Dacus* (*Strumeta*) *laticaudus* Hardy[1] pupae ex *Planchonella*, Deeral, Australia. N. L. H. Krauss, collector. Type in collection Hawaiian Entomological Society. What appears to be the same species was reared from fruit fly pupae ex *Endiandra tooram* and *Acmena macrocarpa* collected in the same locality.

Opius perkinsi n. sp.

Female. Length of body about 3.25 mm.; smooth and shining, finely clothed with silvery hairs; color of body ochraceous, fore and mid legs yellowish, abdomen and hind legs brownish, head also, the color deepening above and behind until almost ebony black on the vertex, post-genae, temples and occiput; eyes, ocelli, antennae, sheaths of the ovipositor also black.

Head transverse, width three times length, wide between the eyes, which are convex, bulging, and well in front; ocelli near the middle of the vertex, the members arranged in the form of an equilateral triangle, the anterior and lateral members an equal distance apart but the distance from the latter to the border of the eye is twice as great; antennae longer than the body, inserted not too close together on the front of the head where the same merges into the face, the sockets deep with elevated rims which laterally approach the inner border of the eye, 39-segmented, scape and pedicel stout, the flagellum filamentous; face a little wider than long, slightly convex although depressed at the sides beneath the antennal sockets; clypeus distinct, the fossae deep; cheeks rather wide; mandibles stout, curved and apically toothed and black at tips, distance from base to margin of eye along clypeocular line not exceeding basal width; maxillary palpi 5-segmented, long, labial 3-segmented, short.

Thorax robust, nearly as deep as long but not quite as wide, wider than head, however; sides of the pronotum deeply sulcate; mesothoracic scutum without complete parapsidal furrows, same indicated by short, deep and wide fossae extending inward from the anterior-lateral corner and a deep pit on the median line near the posterior border; transverse prescutellar sulcus wide and deep and divided by costae into four pits; scutellum triangular, slightly convex on the disc, declivous at the sides; metanotum with a median knob to the raised anterior margin, excavated behind to form a deep groove or sulcus which is costate or ribbed; propodeum convex, declivous behind and at the sides, indistinctly areolate, on the disc a median longitudinal carina, however, extends backward from the anterior margin to middle where it bifurcates to form a triangular areola with apex directed cephalad, sides of the propodeum along with the mesopleura bearing extensive patches of silvery hairs; latter with a wide costate furrow anteriorly and a rather large shallow pit posteriorly at about middle depth; stigmata small and oval.

Abdomen ovate, somewhat compressed apically, the sides anteriorly collapsed; first tergite widening outwardly so that the apical width is more than twice the basal; two laterally placed longitudinal carinae rim a deep basal excavation and extend posteriorly on the disc nearly the whole length of the tergite, sides of which are also margined; the first tergite is separated from the following tergites by a deep furrow which is interrupted in the middle by a knob-like projection from the 2nd tergite; the following tergites all have a transverse line of hairs near their posterior borders. Ovipositor exserted, nearly as long as the abdomen. Legs rather slender, the femora and tibiae, however, somewhat enlarged. Wings hyaline, veins fuscous, radius of anterior wing arising at the middle of the stigma, which is just a little wider than the 1st abscissa of the radial vein is long, 2nd abscissa three times as long as the 1st and exceeding in length the first cubital cross-vein, which is broken before joining the recurrent nervure, so that the first cubital cell is pedicellate and the 2nd is 5-sided. Nervulus in front wing is only slightly post-furcal; nervus parallelus joins the median below the middle. Hind wing is without post-nervellus.

Male is similar to the female in all except secondary sexual characters.

Described from three female and two male specimens (type, allotype and paratypes) reared from *Dacus laticaudus* Hardy pupae ex *Plancho-*

[1] *Dacus laticaudus* is described on page 87 of this issue of the "Proceedings."

nella collected at Deeral, Australia, 1949; Krauss collector. Types in the Hawaiian Entomological Society collection.

Opius froggatti n. sp.

Female. Length of body about 3 mm.; smooth and shining, finely clothed with silvery hairs; color yellowish brown or light ochre throughout, sparsely punctuate with microscopically fine setiferous punctuations, face closely beset; eyes, ocellar space, flagellum of antennae and part of pedicel, sheath of ovipositor and tips of mandibles as well as those of fore and mid tarsi black or blackish, hind tarsi fuscous.

Head transverse, twice as wide as long, wide between the eyes which are convex and on the front of the head as much as on the side; ocelli near the midddle of the vertex, arranged in the form of an equilateral triangle with a depression on outer face, distance to border of eye two to three times that between ocelli; antennae longer than the body, inserted on the front of the head, not too close together at base (much further apart than to border of eye), the sockets deep with elevated rim, 30-segmented, the scape and pedicel stout, the flagellum filamentous; face a little wider than long, convex with median longitudinal ridge between antennal sockets and clypeus, which is prominent and well-marked; cheeks fairly wide; mandibles stout, curved and apically toothed, base as wide as distance to border of eye along clypeocular line; maxillary palpi 5-segmented, long, labial 3-segmented, short.

Thorax robust, nearly as deep as long, width less, but no less than that of head; sides of the pronotum deeply sulcate; mesothoracic scutum without parapsidal furrows, which are represented by faint lines beginning in a deep fossa at the anterior-lateral angle and converging as they extend posteriorly to meet at a deep circular median pit before the posterior margin; transverse prescutellar sulcus divided by costae into eight pits; scutellum triangular, convex on the disc, declivous at the sides; metanotum transverse, elevated medially, depressed laterally; propodeum convex, declivous behind and at the sides, divided by a median longitudinal carina which bifurcates in front and behind, the branches joining lateral carinae so that the disc and sides are more or less enclosed areas; metapleura with a deep, costate, vertical sulcus anteriorly and a large circular, shallow pit posteriorly below middle depth.

Abdomen ovate, somewhat compressed apically, the sides anteriorly collapsed; first tergite strongly bicarinate medially with lateral wings and extreme sides also margined; median area longitudinally striate; following tergites separated from the first by a deep sulcus, which is interrupted medially by an elevation or ridge, the different segments hardly indicated by intersegmental furrows or lines but some of the posterior ones bear a transverse line of fine hairs; ovipositor exserted and only about two-thirds the length of the abdomen; legs fairly slender. Wings hyaline, veins fuscous, radius in anterior wing arising before the middle of the stigma, which is lanceolate; first abscissa extremely short, less than a tenth the length of the second, which is nearly twice as long as the first cubital cross-vein. The latter is broken at two-thirds its length; first cubital cell is therefore long-petiolate. The second cubital is many times longer than wide. Discoidal cell is 5-sided. The nervulus is interstitial; nervus parallelus joins median at about middle. No post-nervellus in hind wing.

Male similar except in secondary sexual characters.

Described from numerous specimens reared from *Dacus laticaudus* Hardy pupae ex *Planchonella* collected at Deeral, Australia, 1949, Krauss collector. Type, allotype and paratype in the Hawaiian Entomological Society collection.

What is considered a form of *Opius longicaudatus* (Ashm.) was also obtained in numbers ex *Planchonella*-infesting *Dacus* at Deeral, and from *Solanum*-infesting pupae on the Atherton tableland; and an opiine indistinguishable from *O. fijiensis* Fúll. was reared in large numbers ex pupae of *Planchonella*- and *Acmena*-infesting fruit flies collected at Deeral.

There is also a single specimen in the collection, reared from pupae obtained from *Solanum auriculatum* on the Atherton tableland in August 1949, which resembles *O. persulcatus* (Silv.).

A new Prionid longicorn Beetle from the Loyalty Islands (Coleoptera: Cerambycidae)

By J. LINSLEY GRESSITT

LINGNAN NATURAL HISTORY SURVEY AND MUSEUM
LINGNAN UNIVERSITY, CANTON, CHINA

(Presented by Dr. D. W. Clancy)

Among specimens of a large collection of Pacific Island longicorn beetles kindly submitted for study by Dr. M. A. Cazier of the American Museum of Natural History there are three species of the subfamily Prioninae represented from New Caledonia and the Loyalty Islands. All were collected by L. Macmillan. One, *Cacodacnus hebridanus* Thomson, taken on New Caledonia, March-April 1939 (Ac. 37523), is already known from the New Hebrides, New Caledonia and Norfolk Island. The second, probably *Megopis* (s. str.) *caledonica* Fauvel, taken on Maré Island, Loyalty Islands on December 17, 1937, is new to the Loyalty Islands. The third species, also from Maré Island, seems to have no very close known relatives. It is placed tentatively in Lameere's subgroup (subtribe) Tragosomae of the tribe Anacolini, though differing from the known members of the group in having the metepisternum narrowed only ventrally and the prothorax strongly narrowed from middle to both apex and base. Four of the seven known genera assigned to this subtribe occur in nearby regions: one in New Zealand, one on Lord Howe Island, one in Tasmania and Australia (Victoria) and the fourth in Australia. The other three are neotropical. This new form also has some affinity with the subtribe Monodesmi of the same tribe. Two of the three genera assigned to that group occur in Central America and the third in Africa and India. The description of the new form follows:

Pteronephila Gressitt, new genus

Antennae and legs slender, fairly long; maxillary palpi long; eyes moderately emarginate; prothorax short, strongly spined at middle of each side; elytra very long, costate; metapisternum broad, arcuately narrowed ventrally and acute apically.

Labrum short, subrounded anteriorly; clypeus membranous, short; mandibles moderate, stout basally, recurved and acuminate apically; maxillae with one lobe visible; maxillary palpi twice as long as labial palpi, with second and third segments longer than fourth; labium short; ligula small and narrow; genae short, with projecting angles; eyes large, coarsely facetted, not very distant above and below, moderately emarginate; antennal supports somewhat raised internally. Antennae slender, only slightly flattened, three-fourths as long as body (male); scape slender, only slightly shorter than third segment and about as long as fourth. Prothorax nearly twice as broad as long, exclusive of lateral spines; strongly narrowed from base of long, slender spine at middle of each side to apex and base; lateral margins almost indistinguishable. Scutellum small. Elytra long and parallel-sided, three and one-third times as long as head and prothorax com-

bined, subrounded apically, each with four distinct discal costae as well as a sutural and marginal one. Anterior coxal cavity reaching nearly to base of lateral prothoracic spine, open posteriorly; intercoxal process triangular, reaching to about middle of coxae; mesosternal intercoxal process narrow; metepisternum broad anteriorly, arcuately narrowed beneath. Legs very slender. Abdomen distinctly narrower than metathorax, strongly tapered posteriorly, hardly more than one-third as long as elytra.

Generotype: *Pteronephila spinifera* Gressitt, new species.

Differs from *Prionoplus* White, of New Zealand, in having the antennae slender, untoothed, unstriated, and non-carinate, the prothorax with basal angles obsolete and unspined, the femora and tibiae untoothed apically and the tarsi long and slender. Differs from *Howea* Olliff in having the antennae simple and shorter, the prothorax spined at middle and the femora slender. *Enneaphyllus* Waterhouse and *Rhipidocerus* Westwood differ in having the antennae lamellate or serrate in both sexes.

Figure 1.—Pteronephila spinifera Gressitt, n. gen., n. sp.; slightly enlarged.

The name of this new genus alludes to a winged spider, since, aside from its wings, this beetle, with its slender appendages and abdomen, is suggestive of the large tropical orb-weaving spiders of the genus *Nephila*.

Pteronephila spinifera Gressitt, new species

Male: Dark pitchy brown, more reddish on metasternum and abdomen; elytra pale buff with costae reddish brown, to pitchy basally, including branch veins, and with some faint clouding of dusky on discs forming a vague X across center, as well as a short longitudinal stripe in first interstice at end of basal fifth, and some more reddish clouding on extreme bases; antennae and legs reddish pitchy, slightly more reddish on femora. Body clothed with suberect whitish buff hairs, more tawny on head, to ochreous on labrum, mandibles and behind eyes; hairs shorter and recumbent on central part of pronotal disc, longest on metasternum, lacking on elytra except for a partial pubescence

of minute recumbent hairs; antennae nearly glabrous, with a few oblique hairs on scape and undersides and apices of following segments; legs with long pale hairs only on bases of femora; distal portions of femora with shorter, subrecumbent pale hairs; tibiae with stouter, short oblique tawny hairs.

Head small, subvertical in front, moderately grooved medially, sparsely and finely granulate along middle of each side, practically impunctate, transversely striate beneath; mandibles shorter than remainder of head; eyes about twice as deep as wide, moderately emarginate, but not embracing antennal insertions, wider beneath, separated above by a distance less than that between antennal insertions, and beneath by a hardly greater distance. Antennae slender, slightly compressed, nearly four-fifths as long as body; scape somewhat thickened beyond middle, fully five times as long as greatest width, nearly three-fourths as long as third segment; second slightly longer than broad; third one-third longer than fourth; fourth to tenth somewhat regularly decreasing in length; tenth one-third as long as sixth, slightly shorter than eleventh. Prothorax short, strongly narrowed from middle to apex and base, with a long slender spine at middle of each side, projecting slightly upward; width at apex as great as length; width to ends of spines twice as great as width of head; disc obliquely inclined anteriorly, armed at middle of each side with a longitudinal ridge extending from anterior to posterior transverse constrictions and strongly raised just behind middle into a laterally compressed crest, rounded subacute in lateral outline and more declivitous posteriorly; remainder of disc minutely punctured, with two subtransverse low ridges across middle and some swellings with a few asperities on each side above the low lateral spine. Scutellum small, subcordate, raised on each side. Elytra wider than prothorax at tips of lateral spines, nearly three times as long as combined breadth, rounded-truncate apically, microscopically punctured, each with five discal costae at base, the first gradually approaching extremely close to sutural margin and nearly fusing with it, second costa, and to some extend third, with some branch veins in basal half, and all with some branches or transverse connectives in parts of distal half, particularly near apex where a partial reticulation exists. Ventral surfaces minutely punctured. Legs slender; femora swollen only in basal halves; hind tibiae as long as basal width of elytra; first hind tarsal segment as long as next two combined, last segment longer than first.

Length 56.5 mm.; breadth 17 mm.

Holotype, male (American Museum of Natural History), Maré Island, Loyalty Islands, Nov. 14, 1937, L. Macmillan.

Differs from other members of the subfamily from the southwestern Pacific in having a single long slender spine on each side of the prothorax, as well as in the combination of very slender antennae, long slender elytra and slender, untoothed legs with the femora much thicker basally than at middle. In the figure, the femora are drawn too stout distally and the basal margins of the elytra are drawn too oblique.

Homoneura vs. Sciomyza in Hawaii (Diptera)

By D. ELMO HARDY

(Presented at the meeting of April 11, 1949)

Homoneura hawaiiensis (Grimshaw) nec Malloch, n. comb.
Sciomyza hawaiiensis Grimshaw, 1902, Fauna Hawaiiensis 3 (2) :84.
Homoneura hawaiiensis Malloch, 1927, Proc. Hawn. Ent. Soc. 4 (3): 383-384.

It has been doubted for some time that the dipterous family Sciomyzidae actually occurs in Hawaii although the family has been recorded frequently in the Hawaiian literature. At the suggestion of C. W. Sabrosky of the U. S. National Museum I have checked the so-called *Sciomyza* in the various collections here and all of the specimens I have seen appear to fit in the genus *Homoneura,* family Lauxaniidae.

Specimens have been sent to the National Museum and Mr. Sabrosky has reported that they are conspecific with *Homoneura hawaiiensis* Malloch. Specimens have also been sent to the British Museum and compared with the type of *Sciomyza hawaiiensis* Grimshaw by H. Oldroyd. He reported as follows: "I feel satisfied that this is indeed *Sciomyza hawaiiensis* G. and agrees well with the type."

The confusion regarding the family to which our species should belong has no doubt arisen because of the character of the postocellar bristles. The most commonly used character for separating the Sciomyzidae from the Lauxaniidae is the slant or direction of the postocellar bristles. The Lauxaniidae usually have the postocellars convergent or crossing while in the Sciomyzidae these bristles are parallel or divergent. This is generally considered a reliable family character but our Hawaiian species is aberrant in this respect. Most specimens of *Homoneura hawaiiensis* (Grims.) have parallel postocellar bristles and on this character would fit in Sciomyzidae. Some specimens have been studied which have convergent postocellars as is typical of Lauxaniidae.

The Hawaiian species in question is placed in its correct family by its conformance with the following characters of the Lauxaniidae:

Two sternopleural, and one mesopleural, bristles present.

Second antennal segment with a strong dorsal bristle.

Front femora with bristles on the undersides.

Anal vein short, extending only about one-fourth the distance to the wing margin.

No strong bristle present on the anterior surface of each middle femur.

Two pairs of strong frontal bristles and head rounded and not strongly produced (typical of most Lauxaniidae).

Studies in Pacific Bibionidae (Diptera)

Part I.

By D. ELMO HARDY
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(Presented at the meeting of December 12, 1949)

The present paper deals with some of the apparently new species of the genus *Plecia* which have come to hand while making a monographic study of the Pacific Bibionidae. As is typical of the members of this genus the species are best distinguished by the characteristics of the male genitalia. The general color characters are of minor importance and are useful only in grouping the species into complexes. In the past, large numbers of species which were similar in coloration were often lumped together under one name.

As will be discussed more fully in the subsequent studies, the family Bibionidae appears to be limited to the southwest portion of the Pacific. The group is apparently entirely lacking throughout Micronesia and Polynesia. Aside from Australia, New Zealand, Tasmania and the larger islands adjoining the Asiatic mainland, the known Pacific species are confined to the Malayan and Papuan zoogeographical divisions and to some of the islands of Melanesia. The majority of the species to date have been described from New Guinea, the Philippines, Borneo, Java and Sumatra.

The species described in this paper and all of the known species of the Australasian region will be keyed in a future report.

The study has been based upon collections received from the British Museum, the United States National Museum, the American Museum of Natural History, the Museum of Comparative Zoology and the Chicago Natural History Museum. The writer is very grateful to these institutions for the privilege of studying this material.

Plecia (Heteroplecia) new subgenus

This is characterized from all other Bibionidae, known to the writer, by the absence of ocelli and of an ocellar triangle. There are no indications of these structures in the specimens which have been studied and the compound eyes of the male are joined on the front up to the hind margin of the head.

This may possibly be a distinct genus although the writer has been unable to find sufficient supplementary characters to justify a generic ranking. A study of additional specimens, including females, in this group may cause a change in the present concept.

Genotype: *Plecia* (*Heteroplecia*) *visenda* n. sp.

Plecia (Heteroplecia) visenda n. sp. (figs. 1 a-b)

This species differs from all other *Plecia* known to the writer by having the ocelli completely lacking. It fits in the *fulvicollis* group by having the thorax all rufous but the male genitalia are very distinctive.

Male. Head: Eyes bare, face, antennae and palpi covered with short black hairs. There are not even rudiments of ocelli or an ocellar tubercle, the eyes are contiguous the entire length of the front and over the vertex. The head is very broad, from a dorsal view it is nearly twice as wide as long. The antennae are situated at the lower one-fourth of the head, as seen from a lateral view. The antennae are 10-segmented and rather elongate, about equal in length to the head. The antennae are chiefly black but the apex of each pedicel and the bases of the first flagellar segments are sometimes yellowish. *Thorax:* Entirely bright orange, except for a narrow brown vitta on the scutellum and for the black tegulae. Halteres with yellow bases and brown to black knobs. *Legs:* Coxae and trochanters yellowish, remainder of legs black; rather densely black haired. *Wings:* Dark brown fumose, darker along the costal margin. The stigmata are not differentiated from the wing membrane. The costa extends about one-third the distance from the tip of R_5 to M_1. Vein R_{2+4} is curved and enters the costa at about a 60° angle to R_5. The section of M_{1+2} between the fork and the r-m cross-vein is two or more times longer than the cross-vein. The cubital cell is open wide at the wing margin. *Abdomen:* Entirely black and densely black haired. *Genitalia:* The tergum and sternum are partly fused laterally on the dorsum (fig. 1a). The ninth tergum is developed into a pair of large forcep-like lobes and is nearly divided into two plates. The posterior median margin of the tergum is almost cordate in shape (fig. 1a). The ninth sternum is developed into a large rounded lobe on each side, which extends nearly three-fourths the length of the clasping structures. The posterior median margin of the sternum has a pair of broad irregular lobes just inside the claspers (fig. 1b). The claspers are large and sharply pointed at their apices (fig. 1b).

Length: body, 9.5 mm.; wings, 11.0-12.0 mm.

Female unknown.

Holotype male and one paratype male: Japen Camp 2, Mt. Eiori, Dutch New Guinea, 2000 ft., Sept., 1938 (L. E. Cheesman). Two paratype males: Hollandia, Neth. New Guinea, rain forest, 250 ft., May, 1945 (H. Hoogstraal).

Type and one paratype returned to the British Museum, one paratype returned to the Chicago Natural History Museum and one deposited in the U. S. National Museum.

Plecia cana n. sp. (figs. 2 a-b)

This species is related to *P. tristis* van der Wulp. It is distinguished by having the thorax entirely light gray, with no black longitudinal stripes; the antennae are also distinctly nine-segmented. Edwards[1] reported that the flagellum of *tristis* contains only four distinct segments. The male genitalia are very distinctive from all known species of *Plecia.*

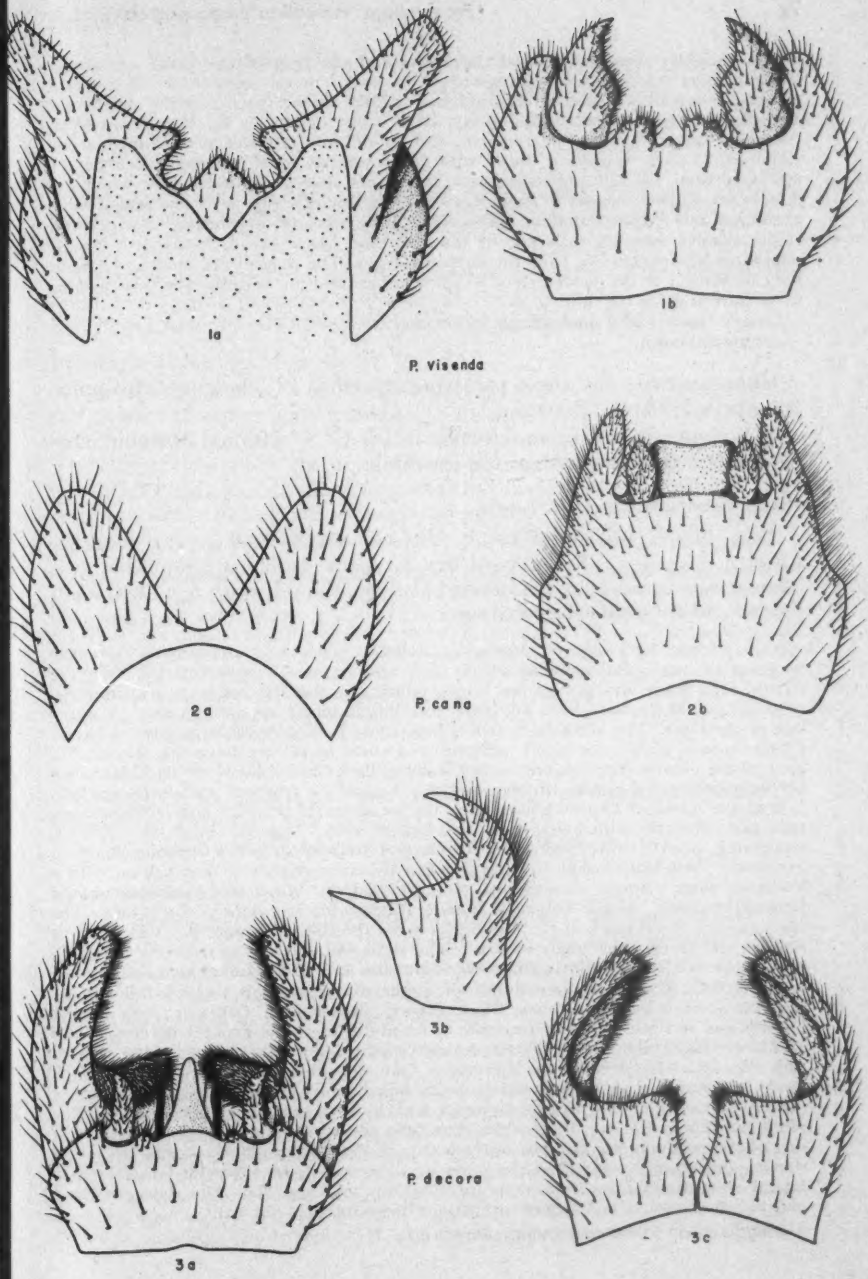
Male. Head: Eyes almost bare, ocellar tubercle very prominent. Face, vertex and occiput densely gray pollinose and very sparsely pilose. Antennae 9-segmented, the apical portion of each pedicel and the base of the first flagellar segment are yellow. *Thorax:* Dark brown to black in ground color, except for the yellowish humeral ridges. The thorax is very densely gray pollinose (almost white) and nearly devoid of pile. The knobs of the halteres are brown, the stems are pale. *Legs:* Chiefly dark brown to blackish, tinged with reddish on the femora. All of the segments are slender, the femora

[1] 1932, Treubia, 14:140-141.

Figure 1. Plecia (Heteroplecia) visenda n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.

Figure 2. Plecia cana n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.

Figure 3. P. decora n. sp. **a.** 9th sternum of male; **b.** clasper of male; **c.** 9th tergum of male.


1a
1b
P. Visenda
2a
P. cana
2b
3b
3a
P. decora
3c

are just slightly thickened toward the apices and the sides of the tibiae are almost straight. The posterior basitarsi are equal in length to the next three subsegments. *Wings:* Yellow-brown fumose, stigmata just slightly darker than the wing membrane. Vein R_{s+4} straight or nearly so, forming about a 65° angle with R_s. Petiole of cell M_1 two times longer than the r-m cross-vein. Cubital cell not narrowed at the wing margin. *Abdomen:* Chiefly brownish, tinged with yellow on the basal half and black on the apical portion. All pile brown to black and rather sparse. *Genitalia:* The ninth tergum is deeply cleft, almost to its base, on the hind margin (fig. 2a). The lateral lobes are broad and rounded at their apices. The ninth sternum is produced into a large, rather slender, lobe on each side of the apex and has a broad, flat-topped, heavily sclerotized lobe protruding from the median margin. The claspers are small and simple; they lie ventral to the median lobe of the sternum and are scarcely over half as long as the lateral lobes (fig. 2b).

Length: body 4.2-4.5 mm.; wings, 5.4-5.8 mm.
Female unknown.

Holotype male and three paratypes: Haight's Pl., Benguet, Philippine Is., April, 1930 (F. Rivera).

Type and two paratypes returned to the U. S. National Museum. One paratype in the Bishop Museum, Honolulu, T. H.

Plecia decora n. sp. (figs. 3 a-c)

This species is related to *P. forcipata* Osten Sacken and *forficula* Edwards because of the forcipate development of the male genitalia. It is distinguished readily by the bilobed claspers, the yellowish legs, discolored thorax and the pale colored wings.

Male. Head: Eyes bare or nearly so, ocellar tubercle very prominent. Antennae 9-segmented, the apical segment is very tiny and is scarcely differentiated from the eighth. The scape and pedicel are bright yellow, the flagellar segments are brown to blackish. All of the head hairs are black and limited to the appendages and the under side of the head. The ocellar tubercle is bare or with very short pubescence. *Thorax:* Chiefly rufous, with three broad, brownish red vittae extending down the dorsum; the area of the pleuron surrounding each spiracle is dark brownish red to blackish. Mesonotum rugose on the sides, in the sunken area just in front of scutellum and just behind the humeri. Thorax almost bare, the mesonotum with very sparse, recumbent, pale pile. Halteres with black knobs and yellow bases. *Legs:* All joints very slender, moderately covered with black hairs. Coxae and trochanters yellow, femora chiefly so except for their black apices. Tibiae and first two subsegments of tarsi yellow, with a brownish tinge. Apical subsegments of tarsi blackish. Hind metatarsi one-third as long as the tibiae. *Wings:* Yellowish fumose, stigmata brown; veins yellow-brown. The costa extends about one-half the distance between the tips of R_5 and M_1. Vein R_{s+4} is oblique and forms a 50° angle with R_s. The section of vein M_{1+2} from the r-m cross-vein to the fork is just slightly longer than the cross-vein. The cubital vein bends down rather sharply at its apex; the cubital cell, at the wing margin, is about as wide as the m-cu cross-vein is long. *Abdomen:* Black, densely black haired. *Genitalia:* Very densely black pilose and conspicuously forcipate. The ninth tergum is strongly developed into a pair of clasper-like lobes and is completely divided into two plates by the median cleft (fig. 3c). The lateral lobes are longer than the remainder of the tergum. Each inner posterior margin of the tergum is developed into a heavily sclerotized and very densely bristled shelf-like area that extends back into the genital chamber (fig. 3a). The ninth sternum is over two times wider than long and has a pair of small lobes on each side of the posterior margin, one on each side of the clasper. The claspers are rather slender and acutely pointed on the outer apex, as seen from a ventral view. From a lateral view the claspers have an acute secondary lobe (fig. 3b). The aedeagus has a pair of rod-shaped, heavily sclerotized, supporting structures (fig. 3a).

Length: body 5.0-6.0 mm.; wings, 6.0-8.0 mm.

Female. Antennae 10-segmented, including the tiny nipple-like tip segment. Front opaque brownish black in ground color, densely covered with grayish pubescence. Front with a very strong ridge down the middle. Ocellar tubercle rather well developed. The upper portions of the pleura are more discolored with blackish than in the males and the wing membrane is more smoky-yellow fumose.

Length: body, 5.5-6.3 mm.; wings, 8.0-10.0 mm.

Holotype male, allotype female and twenty-seven paratypes, eighteen males, nine females; Mt. Tafa, Papua, 8,500 ft., March, 1934 (L. E. Cheesman).

Holotype, allotype and twenty paratypes returned to the British Museum. Two paratypes deposited in the U. S. National Museum, two deposited in the American Museum and three in the Bishop Museum.

Plecia gurneyi n. sp. (figs. 4 a-b)

This species is related to *P. laffooni* n. sp. and is distinguished only by the characters of the male genitalia. The ninth tergum is much broader and the lobes are widely divergent at their apices (cf. figs. 4a and 6b). The claspers are much better developed than in *laffooni* and extend well beyond the apices of the lobes on the hind margin of the sternum. The accessory structures of the aedeagus are rather inconspicuous and barely protrude beyond the hind margin of the sternum (cf. figs. 4b and 6a).

Male. Agrees in all respects with *P. laffooni* except for the genital characters. *Genitalia:* Of the same general form as in *laffooni* but the ninth tergum is much broader than long at its widest point, and the cleft between the two lobes is broadly V-shaped (fig. 4a). The claspers and the aedeagal accessory structures differ as mentioned above. The uppermost of each pair of lateral lobes on the hind margin of the sternum is very small and scarcely visible from a ventral view. The ventral lobe of each pair is rather slender and rounded at its apex (fig. 4b).

Length: body 4.5 mm.; wing, 5.6 mm.

Female. Identical with those of *laffooni.*

Length: body, 4.0-4.5 mm.; wings, 6.0 mm.

Holotype male, allotype female and one paratype female: Bougainville Island, July 15, 1944 (A. B. Gurney).

All have been returned to the U. S. National Museum.

Plecia inconspicua n. sp. (figs. 5a-b)

This species is related to *P. subvarians* Walker, *varians* Edwards and *minor* Edwards by having the ninth sternum of the male genitalia developed into a pair of forcep-like lobes. It is distinguished from these species by the all black pleura and by having the ninth sternum of the male largely membranous in the central portion.

Male. Very tiny, inconspicuous species. *Head:* Eyes bare or nearly so, face thinly pilose. Ocellar tubercle rather strong, with short black hairs on the hind portion and grayish pubescence above. Antennae very short, dark yellow-brown to black and made up of nine rather compact segments. *Thorax:* Mesonotum and scutellum bright orange, except for the brown anterior portion of the former. Thorax otherwise black; halteres black, except for the faintly yellow bases. *Legs:* Entirely black and with all vestiture black. The segments are rather short and are thicker than in most *Plecia. Wings:* Dark brown to blackish fumose, stigmata not differentiated from the wing membrane. Costa extending half way between the apices of R_5 and M_1. Vein R_{5+4} is oblique, forming a 65° angle with R_5. The section of M_{1+2} from the r-m cross-vein to the fork is two

times longer than the cross-vein. The cubital cell is not at all narrowed in the wing margin. The anal vein is strong and extends to the wing margin. *Abdomen:* Black, densely black pilose. *Genitalia:* Both the sternum and the tergum are deeply cleft and strongly forcipate. The tergum is cleft nearly to its base and the lateral lobes are rather acute at apices (fig. 5a). The ninth sternum is almost completely divided into two plates by a broad membranous area in the central portion. The lateral lobes are very slender and elongate (fig. 5b). The claspers are broader than long, rather quadrate in shape and are pointed on the inner apices (fig. 5b).

Length: body, 3.0 mm.; wings, 3.75 mm.

Female unknown.

Holotype male: Kokoda, Papua, 1,200 ft., June, 1933 (L. E. Cheesman); one paratype male, Cyclops Mt., Dutch N. G., 1000 ft., March, 1945 (J. Laffoon). Type returned to British Museum. Paratype returned to the U. S. National Museum.

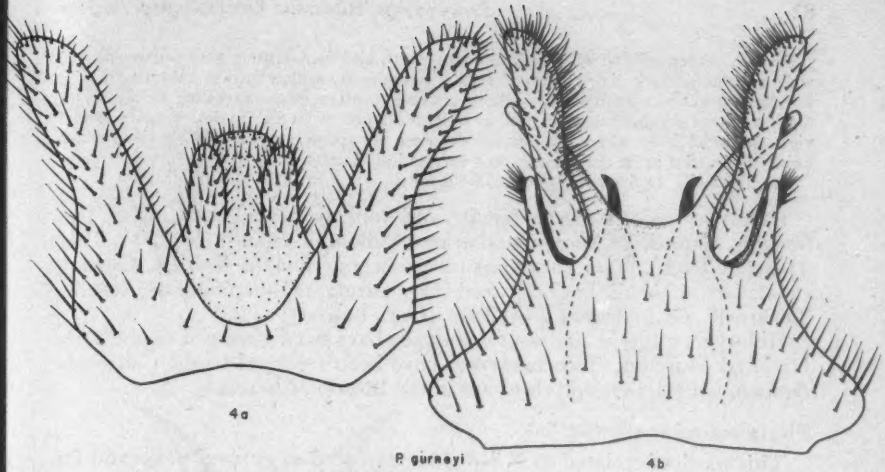
Plecia laffooni n. sp. (figs. 6a-c)

This species is related to *P. gurneyi* n. sp. and to *P. manni* n. sp. The three form a species complex, because of the unusual development of the male genitalia, which appears to be endemic in the Solomon Islands. *P. laffooni* is readily separated from *manni* by the presence of the elongate sub-median lobes on the hind margin of the ninth sternum, as well as by other characteristics shown in the figures. *P. laffooni* is distinguished from *gurneyi* by the differently shaped ninth tergum (figs. 6b and 4a), by the much more elongated apical lobes of the ninth sternum and by the differences in the shape and size of the lateral lobes of the sternum, the aedeagus and the accessory structures (cf. figs. 6a and 4b).

Male. Head: Eyes bare or nearly so. Ocellar tubercle very well developed. Antennae 9-segmented, chiefly brown to black, yellowish on the apical halves of the pedicelli. *Thorax:* Dorsum entirely bright orange, except for a black median vitta on the scutellum. Metanotum brownish yellow, pleura and sternum dark brown to black covered with grayish pollen. Bases of halteres yellowish, knobs black. *Legs:* Entirely black and covered with black pile, all segments slender. *Wings:* Blackish fumose, darker along the costal margin; stigmata scarcely differentiated from the wing membrane. The costa extends one-half the distance between the tips of R_2 and M_1. Vein R_{3+4} is oblique and forms about a 70° angle with R_5. The section of M_{1+2} from the r-m cross-vein to the fork is about equal in length to the cross-vein. The cubital cell is not at all narrowed at the wing margin. *Abdomen:* Subshining black, rather thickly black pilose. *Genitalia:* The ninth tergum is longer than wide and has a very deep narrowly V-shaped cleft on its hind margin (fig. 6b). The anal area is densely pilose, especially from a lateral view (fig. 6c). The hind margin of the ninth sternum is very complex in structure and possesses three strong lobes on each side. The inner pair of lobes is very elongate and bare, rather rod-like; they extend much beyond the apices of the claspers. On each side of the hind margin of the sternum are two densely bristled lobes. One lobe is dorsal in position, extends beneath the base of each clasper and is equal to or longer than the clasping structures. The other lobe is shorter and sharply pointed, and lies directly ventral to the other lateral lobe (fig. 6a). The claspers are simple, rounded at apices and curved inward. The aedeagus is well developed and has a pair of heavily sclerotized accessory structures which extend nearly as far as the lobes of the sternum (fig. 6a).

Length: body, 4.0-4.5 mm.; wings, 5.0-5.7 mm.

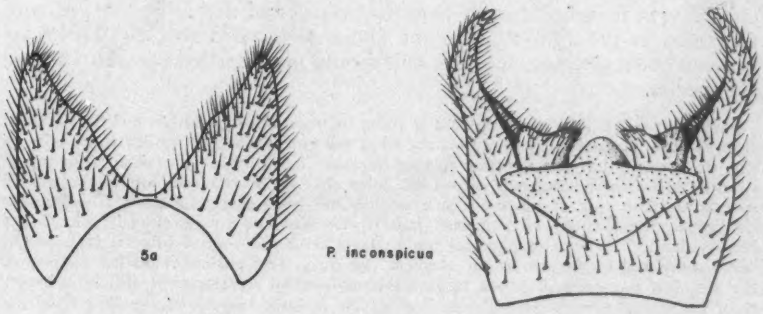
Figure 4. P. gurneyi n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.
Figure 5. P. inconspicua n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.
Figure 6. P. laffooni n. sp. **a.** 9th sternum of male.



4a

P. gurneyi

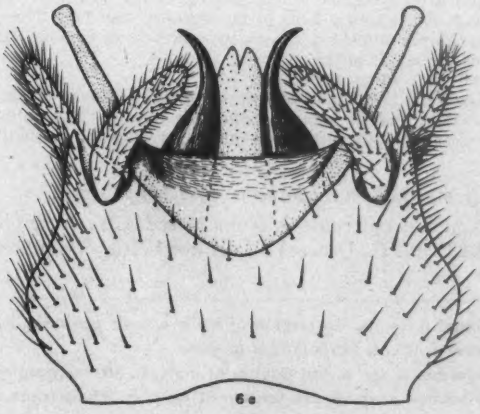
4b



5a

P. inconspicua

5b



6a

P. laffooni

Female. Antennae 11-segmented. Front, occiput and face densely gray pubescent and with scattered black hairs. Front with a prominent, yellow-brown tubercle in the middle just above antennae but without a strong median ridge extending to the ocelli. Ocellar tubercle prominent but not so well developed as in the males. From a dorsal view the head is as wide as long and the eyes are sparsely covered with short black hairs. Otherwise as in the male except for genital characters.

Length: body 4.2-5.0 mm.; wings, 5.8-6.6 mm.

Holotype male, allotype female and four paratypes, two males, two females, Cape Esperance, Guadalcanal, Solomon Islands, Sept. 14, 1944 (Jean Laffoon). Two paratypes, one male, one female, Koli Pt., Guadalcanal, Oct., 1944 (J. Laffoon) and three paratypes, one male, two female, Tenaru R., Guadalcanal, Jan., 1945 (G. E. Bohart).

Holotype, allotype and four paratypes have been returned to the U. S. National Museum. Two paratypes have been returned to the California Academy of Sciences and three are in the Bishop Museum.

Plecia manni n. sp. (fig. 7a)

This species is related to *P. laffooni* n. sp. and to *gurneyi* n. sp. and fits the descriptions of these species except for male genital characters. The cubital vein is rather sharply bent downward and the cubital cell is more narrowed at the apex than in the above mentioned species. This may, however, be a variable character and should not be relied upon to separate the species.

Male. Genitalia: The ninth tergum is about as wide as long and has a deep V-shaped cleft extending nearly to its base on the hind margin. It is very similar to *P. laffooni* (fig. 6b) except that the anterior margin is more extended at the sides. The ninth sternum lacks the median pair of rod-like lobes that are so characteristic of the related species and the pair of lobes on each side of the hind margin are much differently developed. The ventral lobe of each pair is very tiny, poorly developed. The dorsal lobe is slender, rather elongate and much larger than the ventral lobe; it is, however, small compared to the size of the claspers (fig. 7a). The posterior median portion of the sternum is extended into a large semimembranous development which is longer than the remainder of the segment and which extends two-thirds the length of the clasping structures. The claspers are very well developed and elongate. They are obtuse at apices and extend slightly beyond the tip of the aedeagus. The claspers are many times longer than the lateral lobes of the sternum (fig. 7a). The aedeagus has a pair of very strong, sharply pointed, accessory structures, as in *laffooni*. These structures extend well beyond the apices of the claspers.

Length: body, 5.0 mm.; wings, 5.7 mm.

Female. A specimen has been seen that appears to belong here. It was not associated with the male, however, and its identity cannot be certain. The cubital cell is very noticeably narrowed at the apex and at this point is only about one-half as long as the m-cu cross-vein.

Holotype male: Fulakora, Solomons (W. M. Mann).

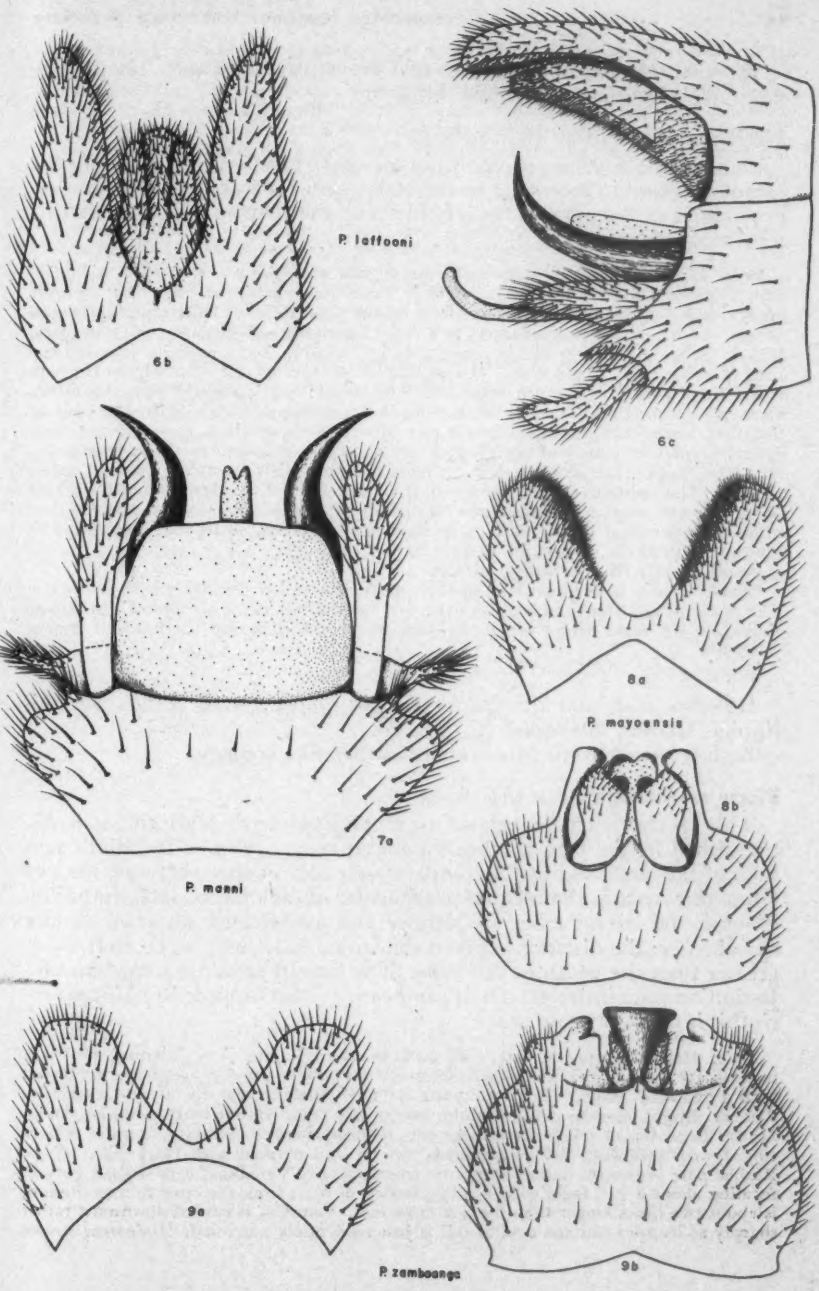
The above mentioned female is from Munda Pt., New Georgia, Solomon Islands, 1943 (W. G. Downs). It is not being designated as an allotype.

Figure 6. **P. laffooni** n. sp. **b.** 9th tergum of male; **c.** male genitalia, lateral.

Figure 7. **P. manni** n. sp. **a.** 9th sternum of male.

Figure 8. **P. mayoensis** n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.

Figure 9. **P. zamboanga** n. sp. **a.** 9th tergum of male; **b.** 9th sternum of male.


P. laffooni
6b
6c
P. manni
7a
P. mayoensis
8a
8b
9a
P. zamboanga
9b

Type returned to the Museum of Comparative Zoology. The female specimen is in the U. S. National Museum.

Plecia mayoensis n. sp. (figs. 8a-b)

This species is distinguished from all other members of the *fulvicollis* complex known to the writer by the male genital characters. The elongate projections at the apex of the sternum and the shape of the claspers will separate it.

Male. Head: Antennae 9-segmented, the flagella are faintly tinged with yellowish. The eyes are bare, the ocellar triangle is large and prominent. *Thorax:* Entirely orange, with very sparse and inconspicuous yellow pile. Stems of halteres orange, knobs brown. *Legs:* Coxae and trochanters yellowish, remainder of legs dark brown to black. *Wings:* Brownish fumose, darker along anterior margin. R_{s+4} straight, entering the costa at about a 65° angle to R_s The section of M_{1+2} from the cross-vein to the fork is two times long than the r-m cross-vein. The cubital cell is slightly narrowed at the apex. *Abdomen:* Dark brown to black, with dark colored pile. *Genitalia:* The apex of the ninth sternum is prolonged into a pair of strongly sclerotized, clavate lobes; these extend beyond the apices of the claspers and are equal in length to the aedeagus (fig. 8b). The claspers are broad and short; from a ventral view they are obtuse at apices (fig. 8b). The aedeagus is well developed, it extends beyond the claspers and has a pair of heavily sclerotized accessory structures directly above and close to the claspers. The ninth tergum is very deeply cleft on its hind margin, nearly to its base (fig. 8a). The inner margins of the tergum are densely haired.

Length: body, 9.0 mm.; wings, 9.1 mm.

Female. Head: Wider than long from a dorsal view, rather densely grayish pubescent. The pedicelli and the basal halves of the first flagellar segments are yellow. Otherwise similar to the male except for genital characters and in having the bases of femora yellowish.

Length: body, 6.0-8.0 mm.; wings, 8.8-9.5 mm.

Holotype male and allotype female: Mt. Mayo, Davao, Mindanao, Philippine Islands, 4000-5000 ft., Jan. 26.

Both returned to the Museum of Comparative Zoology.

Plecia zamboanga n. sp. (figs. 9a-b)

This species is closely related to *P. philippinensis* Malloch. It is distinguished by the broad, bluntly pointed lateral lobes of the ninth sternum of the male, and by the comparatively narrow space between the two lobes; this space is about equal to the width of each lateral lobe. In *philippinensis* the lateral lobes are slender and are divided into two slender apical lobes; the distance between the lateral lobes is three or more times greater than the width of one lobe. The heavily sclerotized median projection on the ninth sternum of *zamboanga* is flat-topped; in *philippinensis* this is distinctly concave.

Male. Head: Eyes nearly bare, with some microscopic pile. The antennae are 9-segmented, the bases of the first flagellar segments are yellow, the other segments are brown with a yellowish tinge. The mouthparts are moderately developed but not elongated. *Thorax:* Bright, opaque yellow in color and nearly bare. Haltere bases yellowish, knobs brown. *Legs:* Coxae yellow, other segments reddish brown to blackish, bases of femora tinged with yellowish. All leg segments slender and covered with black pile. *Wings:* Rather pale brownish, darker along the costal margin. Vein R_{s+4} very slightly curved, forming about a 70° angle with R_s. The section of M_{1+2} from the cross-vein to the fork is about two times longer than the r-m cross-vein. Vein Cu_1 is curved downward rather sharply at its apex but the cubital cell is just moderately narrowed. *Abdomen:* Brown

to blackish with black pile. *Genitalia:* The ninth tergum is deeply cleft almost to its base (fig. 9a). The lateral margins are extended and curve around the sides of the genital chamber. The ninth sternum is largely reddish and has a very large shining black process in the middle, which extends beyond the apices of the other processes. The hind margin of the sternum is developed into a broad, irregular lobe on each side. These are slightly bifid and obtuse at their apices (fig. 9b). The claspers are small and poorly developed, they lie just inside the lateral lobes of the sternum and are very inconspicuous (fig. 9b). The aedeagus is small and is not visible except in end view.

Length: body, 9.0-9.5 mm.; wing, 10.0-10.5 mm.

Female: Antennae 11-segmented, front with a very strong carina down the middle. Otherwise it is like the male, except for sexual characters.

Holotype male: Zamboanga, Mindanao, Philippine Islands (B. P. Clark). Allotype female and seven paratypes, five males, two females, same locality as type, Ac. No. 5122 (B. P. Clark).

Holotype and one paratype returned to the Museum of Comparative Zoology. Allotype and four paratypes returned to the American Museum, two retained in the Bishop Museum.

A new Dacus from Australia (Diptera: Tephritidae)[1]

By D. ELMO HARDY

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UNIVERSITY OF HAWAII

(Presented at the meeting of December 12, 1949)

The following description of an apparently new species of fruit fly is being published at this time in order that the name will be available for use in the fruit fly parasite paper which Mr. Fullaway is publishing in this issue of the "Proceedings". A more complete study of Australian Dacinae will follow at a later date.

The drawings of *D. laticaudus* were made by Miss Marian Adachi.

Dacus (Strumeta) laticaudus n. sp. (figs. 1a-f)

This species is very distinctive; it is somewhat related to *D. cacuminatus* (Hering) but is readily distinguished by the very broad cubital streak, the fumose band on the r-m cross-vein and the short, broad ovipositor of the female. It also differs in many other respects from *cacuminatus*.

The infuscation along the r-m cross-vein reminds one of the wing of *Dacus* (*Strumeta*) *psidii* Froggatt, but these two species differ strikingly in other wing characters, body coloration and structural characteristics.

Male. Head: Front two and one-third times longer than wide, the anterior half is slightly wider than the basal half. The front is yellowish on the margins, reddish in the central portion and with a brown to blackish discoloration on the median tumescence. The swollen portion is densely covered with short brown to black hairs. All of the head bristles are black except for the postoccipital bristles, these vary from brownish to yellow The frontal bristles have no distinct brown spots at their bases. The occiput is chiefly yellow, some specimens have slight brownish discolorations in the median portion. The third antennal segment is rather slender and parallel-sided. It extends about half its length beyond the oral margin. The third segment is four and one-half times longer than its greatest width (the length is measured on the ventral margin from a lateral view). The first antennal segment is two-thirds as long as the second and the second is one-third as long as the third (fig. 1f). The first two segments and the base and inner, ventral margin of the third are yellow; the outer surface and dorsal margin of the third segment are black. The bases of the aristae are yellow. The face is yellow except for the black facial spots, these are large and oval in shape. The spots extend near the oral margin and occupy over one-third the length of the face. The face has a small tumescence just above the middle, the lower half of the face is straight, or nearly so, as seen from a lateral view. The palpi are reddish yellow in color and do not appear to be distinctive in shape. They are gently convex on their lower margins and almost straight-sided on the dorsal margins. The palpi are rounded at their apices. *Thorax:* Chiefly dark rufous in ground color. The two yellow vittae of the mesonotum are shaped as in *D. dorsalis*, except that they end at the suture and the yellow coloring does not extend into or along the suture. The yellow vittae are parallel-sided and obtuse at both ends, the vittae extend just beyond the inner alar bristles. The mesonotum is largely gray pollinose, this pollinosity is broken by a pair of narrow subshining vittae extending the entire length of the mesonotum on a line

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running just inside the inner extensions of the suture. These subshining stripes are blackish behind the suture and reddish on the anterior half of the mesonotum. The broad median, grayish stripe is indistinctly divided by a thin, faintly shining, blackish colored line extending two-thirds the length of the mesonotum, from the anterior margin (fig. 1c). The entire median portion of the mesonotum is brownish in ground color. None of the specimens at hand has the well-defined, black, median vitta characteristic of *cacuminatus*. The humeri and the scutellum are entirely yellow-white. The scutellum has just one pair of bristles, these are situated slightly farther apart than are the prescutellars. The apex of the scutellum is indistinctly trilobed in outline. The metanotum is chiefly reddish brown in ground color, discolored with brown to black in the median and lateral areas. The yellow area of each mesopleuron is broad on the dorsal portion and narrowed below. The top margin fills almost all of the dorsal edge of the sclerite and the ventral edge is scarcely half this wide. The metapleura are more extensively yellow than in *cacuminatus* or related species. Only the median portion of the lower margin is black. The halteres are entirely pale yellow. *Legs:* Almost entirely

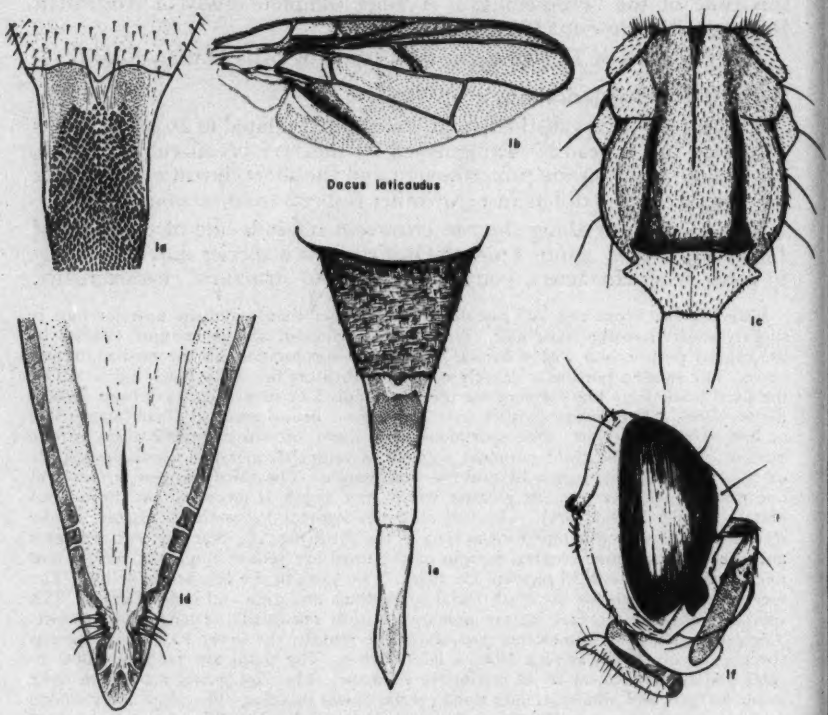

Figure 1a. Basal section of female rasper.
Figure 1b. Wing of female.
Figure 1c. Thorax, dorsal view.
Figure 1d. Apex of female ovipositor.
Figure 1e. Female ovipositor, dorsal view.
Figure 1f. Head, lateral view.

yellow, except for the lightly brownish coxae, trochanters and hind tibiae. *Wings:* The costal cells are entirely hyaline and devoid of microtrichia except for the extreme apical portion. Costal band yellow-brown to faintly grayish and rather broad, extending through all of cell R_5, although the coloring is more faint in this portion. The costal band extends just a short distance into the upper apex of cell R_5. A brown stripe extends from costal band transversely along the r-m cross-vein; this does not extend into cell 1st M_2. The m cross-vein is not fumose and there is no dark spot at the apex of M_{3+4}. The portion of cell R just above cell M is densely covered with microtrichia and is brownish yellow fumose. Cell M is hyaline and bare except for a small clump of microtrichia in the upper corner. The cubital streak is very broad, occupying all of the basal portion of cell M_4 and extending along most of the m-cu cross-vein (fig. 1b). The r-m cross-vein is gently curved and oblique in position. The narrowed portion of the cubital cell is two times longer than the section from the apex of the cubital cell to the wing margin. Abdomen predominantly black, thickly covered with pale pile. The first tergum is all black except for a rufous band on the apex. The second tergum is chiefly yellowish to reddish, with a black spot in the middle at base or sometimes a narrow, transverse brown to black band. The third and fourth terga are all black. The fifth is black in the middle and rufous on the sides. The third tergum has the usual comb of cilia on each side. The genitalia do not appear to be distinctive from other Dacinae.

Length: body, 4.5-5.2 mm.; wings, 4.2-4.8 mm.

Female. Fits the above description except for the secondary and primary sexual characters. The cubital streak does not extend to the wing margin and the wing is not so distinctly lobate at end of cubital vein as in the male. The cubital cell is shorter, the narrowed portion is just slightly longer than the petiole of that cell (fig. 1b). The ovipositor is very distinctive, the conspicuously short and thick segments (fig. 1e) will distinguish this from all other Dacinae which the writer has studied. The seventh segment (oviscape), the inversion membrane (rasper) and the piercer (aculeus) are nearly equal in length. The seventh segment measures 1.15 mm. long (measured from the extreme base on a middle line) by 1.0 mm. wide (measured at the base). The spiracles are located about .16-.18 mm. from the base of the segment (measured to the base on the lateral margins). The inversion membrane is 1.09 mm. long by .35 mm. at its widest point. The rasper extends very close to the base of the membranous segment, to within .1 mm. of the apex of the seventh segment. The rasper is tripointed on its hind margin as seen from a ventral view (fig. 1a). The piercer is 1.02 mm. long by .24 mm. wide (measured at its base) and is gradually tapered. The subapical setae are small and almost equal in size. The third pair is slightly longer than the others and overlies, and often obscures, the fourth pair of setae. The setae arise comparatively near the apex of the piercer; the length of the plate bearing the setae is equal to about half the distance from the fourth pair of setae to the apex of the ovipositor (fig. 1d).

Length: body, 5.5 mm.; wings, 5.0 mm.

Holotype male, allotype female and two hundred paratypes: ex *Planchonella* sp. Collected near Deeral, Queensland, Australia, June, 1949 (N. L. H. Krauss).

The type, allotype and a series of paratypes are being deposited in the United States National Museum. Paratypes are being placed in the following collections: The Board of Agriculture and Forestry, Honolulu; Bishop Museum; Hawaiian Sugar Planters' Association; University of Hawaii; California Academy of Sciences; American Museum of Natural History; Museum of Comparative Zoology and the British Museum.

Notes on the Life History and Ecology of Blossom Midge, Contarinia lycopersici Felt (Diptera: Cecidomyiidae)

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(Presented by Mr. Van Zwaluwenburg at the meeting of December 12, 1949)

Contarinia lycopersici Felt was described in 1911 (2)[2] from specimens reared from tomato flowers at St. Vincent, West Indies. What is apparently the same species has been known to infest tomato blossoms in Hawaii since 1906 (7) when it was reported under the name *Contarinia solani* (Rübsaamen). In a recent paper (5) the writer reported this to be the same species that was described from hibiscus in 1933 (3) under the name *C. maculipennis* Felt. It was shown further that the species infests an exceptionally wide range of host plants in Hawaii. The determined hosts include several species of *Lycopersicon* (tomato), *Capsicum frutescens* L. (garden pepper), *Solanum melongena* L. (eggplant), *Solanum rantonnetii* Carr. (Paraguay nightshade), *Solanum tuberosum* L. (Irish potato), *Momordica charantia* L. (bitter melon), *Hibiscus* sp., *Jasminum sambac* Soland. (pikake) and *Brassica chinensis* L. (white mustard cabbage or pak choy).

Specimens reared in Hawaii appear to be indistinguishable morphologically from those in Trinidad (5). The primary inconsistency between the two areas is that in the West Indies the species has thus far been recorded only from tomato. The name *C. lycopersici* is being applied tentatively to the species in Hawaii. Should this species prove to be distinct from *lycopersici* of the West Indies, then the name *C. maculipennis* will be the valid name for the Hawaiian species.

The present paper summarizes the investigations carried out on the life history and ecology of *C. lycopersici* which were not reported in previous papers (5, 6). The study was made while the writer was at the University of Hawaii during the years 1944-1946.

BLOSSOM MIDGE INJURY

Tomato blossoms infested with midge larvae usually develop characteristic symptoms. The outside of the syngenesious androecium (formed by a fusion of the stamens) frequently develops a yellowish brown color and may show brown and necrotic longitudinal streaks. Inside the androecium the stamens have similar streaks and the tissue is partially broken down and moist. The basal portion usually shows the most injury. The ovary is frequently partially destroyed and becomes brown about the

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[2] Figures in parentheses refer to literature cited at the end of the article.

injured areas. The pistil is less frequently damaged. The petals of infested blossoms often fail to open normally but wilt and crumple down against the androecium. When heavy infestations reach advanced stages before the buds mature, the buds fail to open and are killed.

Blossom drop of tomato due to this midge has been reported several times in Hawaii. In 1944 it was listed by Holdaway (4) as a submajor pest of eggplant and pepper as well as of tomato. Callan (1) believes that in Trinidad it is the most important factor in the destruction of tomato flowers and the resulting loss of crop.

LIFE HISTORY

Eggs. The eggs of *Contarinia lycopersici* are normally deposited on the inside walls of the tube formed by the fusion of the stamens into the syngenesious androecium of the tomato bud. In most cases the eggs are placed in the narrow distal neck portion, but they may also be laid near the base. The adults do not penetrate the walls of the androecium but insert the ovipositor through the open distal end. In two instances dead females were found with their ovipositors still inserted through this aperture. In a few instances eggs have been laid on the outside of the androecium, but this is relatively rare and probably occurs when entry into the androecium is prevented and when the impulse to oviposit is too strong for the female to inhibit until a favorable bud is found.

The eggs usually occur in masses with varying numbers of eggs per mass. They are whitish to cream colored, 0.17 mm. long and about 0.085 mm. wide at the middle. The ends are somewhat tapered and rounded and the egg as a whole is slightly bowed.

The exact incubation period of the eggs has not been determined. It must be very short, however, because the eggs hatch and most of the larval development occurs in about five to seven days.

Larvae. The larvae are whitish in color while young, but as they mature they become yellow and sometimes have a pink cast. Mature individuals vary in length from 1.75 to 2.3 mm. and are about 0.45 mm. wide.

On tomato the larvae feed on the inside walls of the fused stamens and to a lesser extent at the base of the androecium and on the ovary. When present in large numbers in green buds the larva are literally bathed in the fluids released from the injured plant tissues. In heavily infested hibiscus flower buds, the larvae occur among all of the flower parts, such as between the unexpanded petals and around the base of the reproductive organs. The young tight buds are very moist inside when infested, but the larvae find the environment favorable. In the buds of *Jasminum sambac* Soland. the larvae occur anywhere within the flower buds but are found most commonly in the basal portion around the reproductive organs. Some infested buds contain a considerable amount of liquid on the tissue surface. The liquid layer may almost completely envelop the larvae in heavily infested buds which are being severely damaged.

The number of larvae per infested tomato bud varied from 1 to 44 in 104 infested buds for a mean of 7.2 per bud. This was based on dissection of 2089 buds representing several species of *Lycopersicon*.

Midge larvae travel in the soil and within the blossoms by crawling. On an open, exposed surface, however, they jump readily. This is accomplished by drawing the two ends of the body together, thus arching it in the middle, and then flipping the body into the air. By this means they can, in one jump, be thrown into the air about two inches and alight several inches from the starting position.

LENGTH OF LARVAL PERIOD. The normal duration of larval life has not been precisely determined. However, in previously reported breeding experiments on tomato with midge adults reared from hibiscus, pikake and tomato, eggs were laid, hatched and some of the larvae attained mature size within five to seven days (5).

As supplementary evidence that the time required for hatching of the egg and for larval development is short, the results of an experiment on the control of blossom midge with DDT are pertinent. Bounty tomato plants were sprayed or dusted with DDT on May 13, 1944. Three days later 303 buds and blossoms were picked and dissected for larvae and eggs. Records were kept according to the size of the bud. Typically the eggs are laid in the small buds (1-5 mm.). In the 303 treated buds and flowers examined, not a single egg was found, and young larvae occurred in only one.

The results of the examination, according to bud size and larval stage follow: 66 small buds with none infested; 82 medium sized buds, 1 infested with medium sized larvae and 7 with near-mature larvae (0.097 per cent); 81 buds ready to open, 7 infested with medium sized larvae and 14 with maturing larvae (26 per cent); 74 mature flowers, 1 flower with small larvae, 6 with medium sized larvae and 18 with large larvae (34 per cent).

In another planting of Bounty tomatoes, free from DDT treatment, having 37 per cent of the mature flowers infested with larvae, 24 per cent of the young buds were infested with eggs.

DDT prevented oviposition on the treated plants, but apparently did not affect the hatching of eggs already laid or the development of the larvae in the buds. These data indicate that the eggs hatched and the larvae developed at least half way to maturity within the three-day period between treatment and examination except in the case of one mature flower which still carried small larvae. If a longer period for hatching and larval development were required, unhatched eggs and a greater proportion of small larvae would have been present.

When larval maturity is reached, or if the flower begins to dry, or for some other reason becomes unsuitable for the larvae, they leave the flowers and buds and drop to the soil in which they pupate.

Typically adults emerge 14 days after the larvae enter the soil. The length of time normally spent in the soil as larvae, before pupation, was not determined, but the fully mature larvae probably pupate within a day or two. Callan (1) found pupae on the third day after entry of the larvae into the soil, but did not determine how much earlier than the third day pupation occurred.

The present studies revealed that in some circumstances the larvae may remain in the soil for a number of days without pupating. Lack of adequate soil moisture apparently is one factor responsible for retarding or preventing pupation. Larval immaturity also may delay pupation.

Effect of Larval Immaturity at Time of Soil Entry. An experiment was conducted to determine if larvae which had not attained maturity while in the host flowers could develop into adults. On January 12, 1945, small and medium sized larvae from pikake flowers were placed in a pupation vial. All mature larvae were excluded. On January 26, 14 days after the larvae entered the soil, 18 adult males and 6 females emerged. Seventeen days after entering the soil 9 females and 6 males were found in the vial and removed. During the same evening 3 more females emerged. On the 18th day in the soil 3 more females and 2 males emerged.

All of these adults were distinctly smaller than were the adults which developed from obviously mature larvae. Moreover, a number of them required from three to four days longer in the soil than is normally the case. Twenty-four, however, emerged on the 14th day, which is average for normal adults. These results suggest that full larval maturity is not essential for an individual to attain the adult stage. However, larval immaturity at the time of pupation appears to be reflected in smaller adults. Moreover, the pupation period apparently is somewhat extended in some instances.

Pupae. After entering the soil the mature larvae pupate below the soil surface. Rearing experiments indicated that for best results the soil should be moist but not wet. In these studies large glass jars were used for heavy infestations and shell vials three inches high and one inch in diameter were used when small numbers were involved.

A capsule-shaped hollow cell, in which pupation occurs, is formed in the soil by the larva. Some of the pupae visible through the glass of the rearing vials were yellowish white in color while others, presumably older, were brown.

Length of Pupal Period. The exact length of the pupal period has not been determined. The experimental results available deal only with the lapse of time from entry of the larvae into the soil until the adults emerge. Callan (1) reports this as being from 9 to 12 days in Trinidad. In Hawaii a longer period has been found. For apparently mature larvae in suitably moist soil the minimum time is 12 days and the maximum 15 days with a mean of 14 days. This was based on 28 different lots of insects at various times of the year. The plant hosts were tomato species primarily but also included *Capsicum frutescens* L. (pepper), *Solanum rantonnetii* Carr. (Paraguay nightshade), *Solanum tuberosum* L. (Irish potato), *Momordica charantia* L. (bitter melon), *Hibiscus* sp., and *Jasminum sambac* Soland. (pikake). The time used in these results was measured from entry of the larvae into the soil until the appearance of the first adults. In most cases adults continued to emerge for a few days in low numbers. However, it is probable that some of the retarded individuals developed from immature larvae.

When the adults are ready to emerge, the pupae work their way to the surface of the soil where three-fourths of the pupal body is extended almost vertically above the surface with the caudal one-fourth left inserted in the soil to hold the pupa erect. The adult then emerges, leaving the pupal skeleton protruding from the soil.

ADULTS. Typically the adults emerge during the early evening hours between sundown and darkness. A few emerge at other times during the day or night, but they constitute a small minority. In one experiment more than 60 adults emerged during a two-hour period in the evening, and only 15 emerged during the remaining 22 hours of the day.

Neither mating nor oviposition was observed in Hawaii. Callan (1) reports that in Trinidad oviposition begins about 5:30 p.m. and ceases at about 6:45 p.m. in July, when there is little light after 6:30 p.m.

The total number of eggs laid by a single female is unknown. It is probable that one female lays eggs in more than one bud. The number of eggs per infested bud in Hawaii was found to range from one to 37, with a mean of 11.3. This was based on egg counts in 94 infested tomato buds out of 2089 examined.

The blossom midge does not survive long in the adult stage in Hawaii, four days being the longest life recorded for adults caged on tomato plants.

EFFECT OF REDUCED TEMPERATURES. A preliminary experiment was conducted on the effect of reduced temperature on midge larvae and pupae in the soil. Larvae collected from tomato buds at Kipapa Air Field Farm, Oahu, December 7, 1944 were placed in four pupation vials containing moist soil on December 8. The vials, labelled "A", "B", "C", and "D", received the treatments described below.

A This vial was held at normal room temperature as a control.

B After 8 days at normal room temperature, this vial was placed in a room, at 50° F., for six days with a 24-hour period at room temperature between the second and third days in the cold room.

C After 12 days at normal room temperature this vial was exposed to 10 days at 50° F.

D After 12 days at normal room temperature this vial was kept at 50° F. for 26 days.

Group A. Adults began to emerge in the control vial December 22, 14 days after the larvae entered the soil.

Group B. This vial was held at room temperature for 8 days and then exposed to six days at 50° F. with 24 hours at room temperature between the second and third days in the cold room. Three days after being returned to normal room temperature, seven adult males and one female emerged above the soil surface and two additional adults failed to free themselves completely from their pupal skins. All appeared to be weaker than normal. Several other adults had emerged from their pupae within

the soil but failed to reach the surface. On December 29, 21 days after the larvae entered the soil, 13 more adults emerged. These appeared vigorous and normal. A number of larvae had not pupated by the time the vials were removed from the cold room. One larva began to move about within one hour after removal to a warm room. On December 29 it was moving about some in a cell in the soil visible through the glass. On January 4 it had still not pupated and was inactive. By January 16 the soil in the vial had dried out considerably and was remoistened. Within one minute after moisture penetrated to the visible larva it moved out of sight through the soil.

On January 29, 52 days after the larvae originally entered the soil, one female and five males emerged. The fact that emergence of a few adults was retarded for such a long time can be explained partially on the basis of dehydration of the soil. However, in these instances the larvae evidently did not pupate until long after the normal time period despite favorable moisture and temperature conditions during their first eight days in the soil. It is probable, therefore, that they entered the soil before passing that threshold of larval maturity which permits pupation immediately. The delay may thus have been initially due to larval immaturity and subsequently due to inadequate soil moisture.

Group C. This vial, containing larvae which entered the soil December 8, was placed at 50° F. on December 20, two days before the first adults would normally emerge if left at normal room temperature. After 10 days at 50° F. it was removed to room temperature and the soil moistened a little. On January 1 and 2 more than 20 adults emerged. In this experiment the 50° F. temperature held the pupae inactive, but did not kill them and the adults emerged after two more days at normal room temperature.

Group D. This vial was placed at 50° F. on December 20, two days before the adults would normally have emerged. It was left in the cold room for 26 days and then removed to room temperature January 16, 1945. At this time one larva was visible against the glass and within a few minutes in a warm room it began to crawl. By January 19, three days after removal from the cold room, several pupae had crawled through the soil to the glass walls and three had reached the surface of the soil where they died without adult emergence. The soil was moistened, and within a few minutes several larvae could be seen crawling about within the soil.

On January 29, 13 days after removal from the cold room, one live adult female and one live pupa were on the soil surface. By January 31, nine living adults were on the soil surface and five adults had emerged and were caught below the surface.

It appears that the individuals which had pupated and would normally have emerged two days after removal from the cold room, were so affected by the long exposure that they failed to develop into adults. Those which were in the larval stage during the cold period were able to pupate and emerge as adults two weeks after removal from the cold room.

SUSCEPTIBILITY AND RESISTANCE TO MIDGE ATTACK IN THE GENUS LYCOPERSICON

An interesting relationship was found to exist between the blossom midge and some of the species of tomato which it infests in Hawaii. The commercial tomato, *Lycopersicon esculentum*, variety Bounty, which was commonly grown in Hawaii was found to be a very susceptible host of the blossom midge. At Poamoho, Oahu, July 25, 1945, Bounty strains of tomato were so heavily infested with midge larvae that Dr. W. A. Frazier and Dr. J. S. McFarlane of the University of Hawaii Vegetable Crops Department found it difficult to obtain uninfested flowers to use in pollination work.

On the University of Hawaii campus, in Manoa Valley, the percentage infestation of Bounty buds and flowers commonly ranged from 30 to 50 per cent during the early summer of 1944. Several other species of *Lycopersicon* were being grown on the campus for use in tomato breeding. Midge counts in the buds and blossoms of these wild type tomatoes revealed a strikingly low percentage of infestation compared with Bounty tomatoes growing but a few feet away. *Lycopersicon peruvianum*, which produces a profusion of flowers, was found to have a consistently low infestation. Tables 1 and 2 present a comparison of the infestation in *peruvianum* and Bounty. The results of two days' sampling of each tomato are combined. May 3 was a sampling date common to both species. There was no significant difference in the percentage infestation between the sampling dates.

The tables show that 50 per cent of the buds and blossoms of Bounty were infested with either eggs or larvae as compared with only 6.0 per cent for *peruvianum*.

One probable cause of the marked difference in susceptibility to midge attack shown by these two tomatoes is found in the structure and type of development of the flower buds. The midge adults lay their eggs inside the androecium, usually in the distal portion. They are not able to puncture the tissue, but insert the ovipositor through the open distal end. In *L. esculentum* the petals on the flower buds do not fit tightly into the open end of the androecium and thus permit oviposition while the buds are very small. As indicated in Table 1 the eggs are laid primarily in the very young buds of Bounty and only rarely in the maturing buds and flowers. In contrast, the petals of *peruvianum* fit tightly together against the androecium and the distal ends of the green petals bend over and fit into the neck of the androecium so firmly that oviposition is mechanically obstructed. The petals usually remain in this position until the bud is almost ready to open. Accordingly, only rarely are eggs to be found in the young buds (where they predominate in *esculentum*) and the number of half grown buds is also only slightly infested. Most of the eggs cannot be laid until the buds are ready to open or are opening. In the case of three of the *peruvianum* buds infested with eggs, the midge had not been able to place them inside the androecium and had laid them on the outside.

Table 1.—Infestation of Bounty Tomato Buds and Blossoms with Eggs and Larvae of Contarinia lycopersici Felt (April 29 and May 3, 1944)

	Young buds (1-5 mm. long)		Maturing buds (5-10 mm. long)		Open flowers		Totals	
Number examined	26		40		45		111	
Buds and blossoms infested:	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae
Number	8	4	3	23	0	17	11	44
Per cent	30.7	15.3	7.5	57.5	0	38	10	40

Table 2.—Infestation of Lycopersicon peruvianum Buds and Flowers with Eggs and Larvae of Contarinia lycopersici Felt (May 1 and May 3, 1944)

	Young buds (1-5 mm. long)		Maturing buds (5-10 mm. long)		Open flowers		Totals	
Number examined	106		184		173		463	
Buds and blossoms infested:	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae
Number	1	0	11	2	4	10	16	12
Per cent	0.94	0	6.0	1.08	2.3	5.8	3.4	2.6

Since *peruvianum* is not suitable for oviposition until the buds are ready to open there is little time left for the eggs to hatch and for the larvae to mature before the open flower becomes unfavorable for the larvae. Nearly all the larvae recorded from *peruvianum* were small or medium in size.

On May 10, 1944, another sample of 384 buds and blossoms of *peruvianum* were dissected. Of the 26 small buds taken none was infested. One of 76 medium sized buds was infested with two small larvae. Four of 88 buds ready to open were infested with eggs (those in one case occurring on the petal), and two were infested with larvae. Of these two, those in one bud were small and those in the other bud were near maturity. Of 194 open flowers examined, three were infested with eggs. Six of the flowers were infested with larvae, four having small larvae, one with medium sized larvae and one with large larvae. Of the total 384 blossoms taken, 1.8 per cent carried eggs and 2.3 per cent carried larvae.

Lycopersicon chilensis was found to be similar to *peruvianum* in midge infestation. Of 159 buds and blossoms collected and examined May 1, 1944, 26 small buds were uninfested, two of 47 half grown buds carried eggs, 31 buds ready to open were uninfested and of 55 mature flowers examined one was infested with eggs and one with larvae. The combined infestation of eggs and larvae amounted to only 2.5 per cent of the sample.

The adults prefer to lay their eggs in young buds whose growth to maturity approximately parallels that of the larvae. The percentage of maturing buds infested with eggs is about the same in Bounty as in *peruvianum*. This indicates that the failure of the midge to infest a high percentage of *peruvianum* buds at a stage when they are ready to open, and

thus accessible to ovipositing adults, is not due to avoidance of *peruvianum* more than Bounty, but rather due to an inherent reluctance to lay eggs in late stage buds and flowers whether they be Bounty or *peruvianum*.

CONTROL OF BLOSSOM MIDGE WITH DDT

In a preliminary experiment DDT was applied to Bounty tomatoes at the rate of one pound of 20 per cent DDT wettable dust to 100 gallons of water, 1 per cent DDT dust and 2 per cent DDT dust in pyrophyllite. Each treatment was replicated twice and two plants were in each replication. Check plants grew adjacent to the treated plants and were thus partially contaminated by the treatment. The treatment was applied May 13, 1944, and infestation counts were made three days later.

The pertinent results follow: No eggs were found in any of the buds or blossoms except in one flower on a control plant. From 19 to 25 small buds (1-5 mm.) were examined for each treatment and all were free of eggs and larvae—including those on the control plants.

DDT Spray: Of 32 medium buds examined none was infested. Of 57 maturing buds and open flowers 21 (36.8 per cent) carried larvae. *1 per cent DDT Dust*: Of 22 medium buds examined 2 (9 per cent) were infested with larvae. Of 57 maturing buds and flowers, 17 (30 per cent) were infested with larvae. *2 per cent DDT Dust:* Of 28 medium buds examined, 6 (21.4 per cent) were infested with larvae as were 10 (24.4 per cent) of 41 maturing buds and flowers. *Check*: 6 (17.1 per cent) of 35 medium buds were infested with larvae. Of 32 maturing buds 1 was infested with eggs and 12 (37.5 per cent) carried larvae. Of 33 mature flowers 8 (24.2 per cent) were infested with larvae.

Of a total of 423 buds and blossoms examined 81 were infested as follows: 1 bud with eggs, 2 buds with small larvae, 17 buds and blossoms with medium sized larvae, and 61 with maturing larvae.

It is evident from these results that DDT dust and spray prevented the adults from ovipositing. Of special interest is the fact that oviposition was prevented (except in one instance) on the control plants as well. They were adjacent to the treated plants and probably also became partially contaminatd during treatment. Moreover the presence of a predominance of treated plants would affect the midge activity on adjacent control plants. This was borne out later in the season when plots (four plants each) were treated with 1 per cent DDT dust, and 2 per cent DDT dust, each treatment being replicated six times. This was set up for thrips control studies, and the flowers were not examined until six days after treatment. In this case also blossom midge was controlled and no larvae were found in any plants except 2 flowers on control plants. The treatment, repeated every 8 days, resulted in an elimination of the midge population from the control plants as well as from the treated plants.

That the treatments applied were responsible for the above results is indicated by the fact that untreated Bounty tomatoes a few hundred yards removed continued to be infested during this period to about the same degree as before. On May 26, 30 per cent of the maturing buds on untreated plants were infested with larvae.

SUMMARY

The life history of blossom midge, *Contarinia lycopersici* Felt, in Hawaii is discussed. The eggs are laid inside the androecium of the tomato flower buds. They hatch and the larvae mature within five to seven days. They then enter the soil where they pupate. Adults normally emerge 14 days after the larvae enter the soil.

Larvae which are forced to leave the host plant before attaining full size and maturity are nevertheless able to pupate and become adults. The adults reared from such larvae, however, are smaller in size than normal. Moreover, such larvae may spend a longer time in the soil before pupating than do the mature larvae.

Data are presented on the effects of reduced temperature on survival and development of larvae and pupae in moist soil.

Commercial varieties of tomato, such as Bounty, were found to have 50 per cent of the buds and blossoms infested with larvae or eggs, while *Lycopersicon peruvianum*, growing in adjacent rows, carried only a 6 per cent infestation. The difference appears to be due to the fact that in *peruvianum* the petal tips fit tightly into the distal end of the androecium of the young buds and prevent the midge adults from inserting the ovipositor.

DDT dusts and sprays protected Bounty tomato plants from oviposition but did not prevent hatching of the eggs already laid or interfere with the development of the larvae inside the buds.

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The Aculeate Hymenoptera of Micronesia
II. Colletidae, Halictidae, Megachilidae, and Apidae

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Part I, treating the Micronesian wasps of the families Scoliidae, Mutillidae, Pompilidae, and Sphecidae, has been published (Proc. Hawaii. Ent. Soc. 13:367-410, 1949). Part II deals with all the bees now known to occur in Micronesia, and includes additional notes and records of the wasp fauna, an appendix to Part I. A bibliography of papers dealing with bees is also included in Part II. Illustrations for Parts I and II are both in this part, since the services of an artist were not available when the text for Part I was prepared.

The material on which Part II is based is comprised mainly of the collections noted in the introduction of Part I. Additional specimens have been made available by the California Academy of Sciences (CAS) through Dr. E. S. Ross, by the Chicago Natural History Museum (CNHM) through Dr. H. S. Dybas and by the Kyushu University (KU) through Dr. K. Yasumatsu. The material collected by Dr. Dybas in Micronesia in 1947-48 under the auspices of the Pacific Science Board has also formed an important additional source of specimens; the first set of this material has been deposited in the U. S. National Museum, the second in the Chicago Natural History Museum and the third in the Bishop Museum. Miss L. E. Cheesman has kindly furnished some notes on the type of *Megachile hedleyi* Rainbow.

DISTRIBUTION OF MICRONESIAN BEES

(An asterisk denotes an endemic or supposedly endemic species.)

COLLETIDAE

***Hylaeus (Hylaeus) guamensis** (Cockerell). Marianas (Guam)
***Hylaeus rotensis** (Yasumatsu). Marianas (Rota)
***Hylaeus (Hylaeus) yapensis** (Yasumatsu). Carolines (Yap)
***Hylaeus hirticaudus** Cockerell. Carolines (Palaus)

HALICTIDAE

***Halictus (Indohalictus) yapensis** Cockerell. Carolines (Ponape, Truk, Ulithi, Yap, Palaus)
***Halictus (Homalictus) palaonicus** Cockerell. Carolines (Yap—?, Palaus)
***Halictus (Homalictus) nummatus** sp. n. Carolines (Yap)

*Halictus (Homalictus) auriger sp. n. Carolines (Kusaie, Ponape)
*Halictus (Homalictus) saffordi Cockerell. Marianas (Guam)
*Halictus (Homalictus) swezeyi Cockerell. Marianas (Guam, Rota, Saipan)
*Halictus (Homalictus) rotaënsis Cockerell. Marianas (Rota, Tinian)
*Halictus (Homalictus) vexator sp. n. Marianas (Agrihan)

MEGACHILIDAE

Lithurgus (Lithurgus) scabrosus (Smith). Marianas (Guam, Saipan, Tinian, Agrihan), Carolines (Kusaie, Ponape, Truk, Yap, Palaus)
*Heriades (Michenerella) paganensis Yasumatsu. Marianas (Guam, Tinian, Saipan, Pagan)
*Heriades (Michenerella) plumosa sp. n. Carolines (Palaus)
Megachile (Eumegachile) umbripennis Smith. Marianas (Saipan)
Megachile (Eutricharaea) fullawayi Cockerell. Marshalls (Majuro, Eniwetok, Kwajalein and Jaluit Atolls), Marianas (Guam, Pagan, Agrihan), Carolines (Kusaie, Kapingamarangi, Nukuoro, Truk)
Megachile laticeps Smith. Marianas (Guam, Rota, Tinian, Saipan, Pagan, Agrihan), Carolines (Kusaie, Ponape, Truk, Yap, Palaus)
Megachile diligens hedleyi Rainbow. Marshalls (Kwajalein, Eniwetok, Ailinglapalap, and Bikini Atolls), Carolines (Murilo Atoll—?)
*Megachile palaonica Cockerell. Carolines (Palaus)

APIDAE

*Ceratina mariannensis Yasumatsu. Marianas (Rota, Saipan)
*Ceratina palauensis Yasumatsu. Carolines (Palaus, Yap, Ulithi, Truk)
Xylocopa brasilianorum varipuncta Patton. Marianas (Guam, Saipan)
Trigona (Tetragona) fusco-balteata Cameron. Carolines (Palaus)
Trigona (Tetragona) iridipennis var. valdezi Cockerell. Carolines (Truk)
Apis mellifera Linnaeus. Marianas (Guam, Saipan), Carolines (Ponape, Palaus)

GENERALIZATIONS ON THE ENDEMIC ACULEATE FAUNA

No endemic species are known from the Marshalls, nor is it likely that any occur there, for all the islands are low atolls. For purposes of tabulation and discussion the remaining islands may be divided into several groups: The northern Marianas, comprising the islands from Medinilla north (aculeates have been collected on Pagan and Agrihan only in this group); the southern Marianas, comprising the islands from Guam to Saipan; the most eastern Carolines (Kusaie, Ponape); the central Carolines (Truk and surrounding atolls); Yap Island and Ulithi Atoll in the western Carolines; and the Palaus in the far western Carolines.

The accompanying table lists the known endemic species in Micronesia, the Caroline Islands from west to east in descending order, and the Mariana Islands from south to north in descending order. While the Palaus comprise a number of islands, they are separated from each other by short distances only, and since many of the species apparently occur on all islands of the Palaus on which collections have been made, the entire group has been treated as one island.

Table 1.—Endemic Aculeate Hymenoptera in Micronesia (species marked with an asterisk are perhaps endemic on more than one island).

CAROLINE ISLANDS

PALAUS
Campsomeris palauensis
Timulla sp.
Episyron maehleri
Pseudonortonia esakii
Pseudonortonia palauensis
Lestica constricta
Dasyproctus immaculatus
Motes townesi
Liris williamsi
Pison korrorense
Hylaeus hirticaudus
*Halictus yapensis
*Halictus palaonicus
Heriades plumosa
Megachile palaonica
*Ceratina palauensis

YAP
Pseudonortonia yapensis
Liris esakii
Hylaeus yapensis
*Halictus yapensis
*Halictus palaonicus
Halictus nummatus
*Ceratina palauensis

TRUK
Liris carolinensis
*Halictus yapensis
*Ceratina palauensis

PONAPE
Pison nigellum
Pison ponape
*Halictus yapensis
*Halictus auriger

KUSAIE
*Halictus auriger

MARIANA ISLANDS

GUAM
*Polistes semiflavus
*Pison esakii
*Pison oakleyi
Hylaeus guamensis
Halictus saffordi
*Halictus swezeyi

ROTA
*Polistes semiflavus
*Odynerus mariannensis
*Pison esakii
*Pison oakleyi
Hylaeus rotensis
*Halictus swezeyi
*Halictus rotaënsis
*Ceratina mariannensis

TINIAN
*Pison esakii
*Halictus rotaënsis

SAIPAN
Odynerus saipanensis
*Halictus swezeyi
*Ceratina mariannensis

PAGAN
Odynerus paganensis
Heriades paganensis

AGRIHAN
Halictus vexator

Dispersion has unquestionably been from the Palaus eastward. The most western group, the Palaus, has by far the largest endemic fauna, and families (Scoliidae, Mutillidae, Pompilidae) and genera (*Lestica, Dasyproctus, Motes, Megachile*) occur there which are not represented elsewhere in Micronesia by endemic species. So far as I can determine, the affinities of such endemics as the Palau species of *Campsomeris, Lestica, Dasyproctus,* perhaps the *Timulla,* and the wide-ranging (in the Carolines) *Halictus* (*Indohalictus*) *yapensis* appear to be with species of the Moluccas-New Guinea-Solomons area, rather than with elements in the Philippines. However, the fauna of the Philippines and Austro-Malayan region is so poorly known on the whole that it is not possible to state that all or most of the dispersion in Micronesia has been from the Moluccas-New Guinea-Solomons area.

The next large island to the east is Yap. The endemic fauna is much smaller, and several species are shared with the Palaus on the west and Truk and Ponape to the east. One peculiarity of the Yap fauna is that in species belonging to genera customarily having yellow maculations, the most extensively maculated of all the Micronesian species are those occurring on Yap. This phenomenon may be noted in *Pseudonortonia yapensis* in the Vespidae and *Hylaeus yapensis* in the Colletidae. Both of these genera also have endemic species in the Palaus, and *Hylaeus* also in the Marianas, but none of them is so brightly colored as the Yap representatives.

Truk likewise has a very small endemic fauna and as recorded to date only one of the species is confined to Truk alone, though Dr. Yasumatsu informs me that he has a new *Pison* from Truk.

Ponape has two endemic *Pison* which do not occur elsewhere, and one endemic *Halictus* which occurs also on Kusaie. More thorough collecting on these two islands might turn up a few additional endemics in such genera as *Ceratina, Hylaeus,* or *Pseudonortonia.*

The Marianas as a whole have a larger endemic fauna than any other island group in Micronesia with the exception of the Palaus. The individual islands, however, have very few endemics. There are several peculiarities to be noted about the aculeates of the Marianas, such as the development of three endemic *Odynerus sens. lat.* which are apparently more closely related to species occurring in Hawaii than elsewhere in Oceania (personal communication from Dr. Jos. Bequaert), the presence of a supposedly endemic *Polistes* no other species of which are endemic in Oceania, and the fact that none of the species endemic to the Marianas occurs also in the Carolines and vice versa. Yasumatsu has recorded the Marianas *Ceratina mariannensis* from Yap and Truk, but this is a misdetermination, and the specimens are referable to *palauensis.*

The southern Marianas have a dozen endemic species, most of which occur on more than one of the included islands. The fauna of the northern Marianas is comparatively much more poorly known, but undoubtedly is much smaller. To date there is one *Halictus* known from Agrihan, and one *Odynerus sens. lat.* and one *Heriades* from Pagan, the last species occurring also in the southern Marianas, though probably introduced on those islands during the war, as it was not taken on any of the earlier Guam surveys.

Certain other tendencies may be noted in a comparison of the endemic aculeate fauna. In the genus *Odynerus sens. lat.* endemic forms with highly polished and relatively impunctate integument and darkened wings occur in the Marianas. *Pison esakii* in the southern Marianas is a similar case. There are no close relatives of these two groups elsewhere in Micronesia. In the endemic species of *Liris* occurring respectively in the Palaus and more eastern Carolines (Yap and Truk), the Palau *williamsi* is the more densely punctate, has a duller integument and pale wings, while the Truk *carolinensis* is more polished, less densely punctate and has strongly infumated wings, and the Yap *esakii* is intermediate in wing color. A similar condition in relative density of the

punctation is also to be noted in the two endemic *Ceratina* from the Carolines and Marianas respectively. Micronesian *Heriades* (*Michenerella*) differ by the rather dense discal plumose pubescence on the terminal abdominal tergites, whereas other species belonging to this subgenus from the Philippines and Asiatic mainland have only very sparse simple hairs discally on these tergites.

The percentage of endemism in the bees is much higher than in the wasps. Of the 26 known species of bees, 17 are endemic, while of the 52 wasps (49 recorded in Part I of this series, one additional in the appendix to Part I, and Dr. Yasumatsu writes that he has two additional undescribed endemic *Pison*), only 23 are endemic. I believe that this higher percentage of endemism in the bees is undoubtedly an expression of their more complicated and direct relationship with plants, since many bees which might otherwise be well adapted to survive in Micronesia are unable to do so because the plants they visit for pollen for provisioning their cells, or for resins and gums for nest construction, do not occur in Micronesia. The much higher survival of the introduced species of wasps may be attributed to their not being too selective in prey preference, or if they are, such preferred hosts are already to be found in Micronesia.

It is interesting to note that there has been no "explosive" development of a number of endemic species on any one island in Micronesia, such as in the Samoan halictine bees, or the Hawaiian eumenine, crabronine and psenine wasps and hylaeine bees.

KEY TO THE FAMILIES OF MICRONESIAN BEES[1]

[1] Only the genera now occurring in Micronesia will key out properly.

1. Forewing with two closed submarginal cells 2
   Forewing with three closed submarginals, or these cells entirely absent (*Trigona*) 3
2. Females with a ventral scopa on abdomen composed of simple hairs; males usually with four or fewer visible abdominal sternites, if with six (*Lithurgus*), the abdominal sternum with dense plumose hairs and integument of head entirely black ..... **Megachilidae**, p. 118
   Females without a scopa on venter of abdomen or hind legs; males with six visible abdominal sternites bearing only sparse, simple hairs, the head always with some yellow integumental markings ..... **Colletidae**, p. 105
3. First submarginal cell longer on cubital vein than second and third cells combined, three submarginals always distinct though the third transverse cubital vein is weaker than the others; females with a scopa of long curled plumose hairs on venter of abdomen in addition to a scopa on hind legs ..... **Halictidae**, p. 109
   First submarginal cell never as long on cubital vein as the second and third cells combined, or no closed submarginals present; females never with an abdominal scopa, the scopa if present always on hind legs, or the hind tibia flattened and lined with long hairs to form a corbiculum or pollen basket ..... **Apidae**, p. 131

FAMILY COLLETIDAE

It is quite likely that the key given below may be rather unsatisfactory. I have had both sexes of *yapensis* (Yasumatsu) and *guamensis* (Cockerell), and females of *hirticaudus* Cockerell only, so many of the separation characters had to be taken from the original descriptions,

which are based mainly on color. All species are endemic, and it is not improbable that additional forms may be found on such high islands as Ponape and the northern Marianas.

Hylaeus guamensis and *H. yapensis* are referable to the typical subgenus. I suppose the other Micronesian species also belong there, but the male genitalia and retracted sternites must be examined before subgeneric assignments can be made.

Specimens of *guamensis* were reared from nests in a rotten branch of mangrove by O. H. Swezey, and H. S. Dybas found *hirticaudus* nesting in a log. Nothing is known as to the ethology of the other species, but presumably it is quite similar.

KEY TO THE MICRONESIAN COLLETIDAE

1. Abdomen usually ferruginous in part or entirely; yellow markings more extensive than in other species, pronotal band complete, space between lateral margin of clypeus and inner eye margin entirely yellow, females with yellow spots on clypeus, mesoscutum anterolaterally and axillae; punctation of thorax much denser, almost all the punctures on mesoscutum uniformly subcontiguous; male genitalia and retracted sternites as figured (figs. 1, 4, 5, 8); Carolines (Yap) ..... **Hylaeus (Hylaeus) yapensis** (Yasumatsu), p. 107

   Abdomen never ferruginous, occasionally dark brown on basal segments, but usually black with obscure metallic green reflections; yellow markings much less extensive, pronotal band always interrupted in middle, space between lateral margin of clypeus and inner eye margin not entirely yellow (needs confirmation in *rotensis*), females without yellow markings on clypeus, mesoscutum or axillae; punctation of thorax much sparser, that on mesoscutum not uniformly subcontiguous, but the punctures separated by a little less than or as much as the width of a puncture (needs confirmation in *rotensis*) 2

2. Scutellum and postscutellum entirely black; female unknown; Marianas (Rota) ..... **Hylaeus rotensis** (Yasumatsu), p. 107

   Scutellum and postscutellum with large yellow marks 3

3. Male: upper margin of yellow mark on clypeus irregular, supraclypeal mark present; yellow mark on scutellum larger than on postscutellum, the anterior margin of the mark on the former straight; genitalia and retracted sternites as figured (figs. 2, 3, 6, 7). Female: pronotal collar not produced above level of anterior part of mesoscutum, scarcely notched in middle; yellow mark on scutellum covering the entire disk except narrow anterior margin. Marianas (Guam) ..... **Hylaeus (Hylaeus) guamensis** (Cockerell), p. 106

   Male: upper margin of yellow mark on clypeus rounded, the supraclypeal mark absent (?); yellow mark on postscutellum as large as that on scutellum, the anterior margin of the mark on the latter with a median notch. Female: pronotal collar strongly produced above level of anterior part of mesoscutum and with a broad, deep notch in middle; yellow mark on scutellum less extensive, covering only the posterior half or two-thirds of disk. Carolines (Palaus) ..... **Hylaeus hirticaudus** Cockerell, p. 107

Hylaeus (Hylaeus) guamensis (Cockerell) (Figs. 2, 3, 6, 7)

Prosopis sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:282 [♀, ♂; Guam].

Prosopis guamensis Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:4 [♀, ♂; Guam; type and allotype in U. S. National Museum].

Hylaeus guamensis (Cockerell), Cockerell, 1942. B. P. Bishop Mus. Bul. 172:189 [♀, ♂; Guam; reared from nests in rotten branch of mangrove].

Hylaeus sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Guam].

Some comparative notes are given in the discussions of the other species below. I have examined the following material:

Mariana Islands: 1 ♀, 1 ♂; Guam (D. T. Fullaway; type and allotype). 1 ♂; Guam. 2 ♀ ♀, 1 ♂; Sumay Road, Guam; June 23, 1936 (O. H. Swezey; from nest in dead *Lumnitzera*).

Hylaeus rotensis (Yasumatsu), new combination

Prosopis rotensis Yasumatsu, 1939. Tenthredo 2:329, figs. 2, 3 [♂; Rota; type in Kyushu University].

Hylaeus sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Rota].

I have had no material of this species, apparently still known only from the unique male type. The description does not differ in any essential particular from males of *guamensis* except that *rotensis* has the scutellum and postscutellum black. Perhaps it will be ranked as a subspecies of *guamensis* when specimens of the two can be compared.

Hylaeus (Hylaeus) yapensis (Yasumatsu), new combination (Figs. 1, 4, 5, 8)

Prosopis yapensis Yasumatsu, 1942. Tenthredo 3:346, figs. 1-4 [♀, ♂; Yap; type in Kyushu University].

This species is quite distinct from the other Micronesian *Hylaeus* in having the abdomen red in part or entirely. In the other species the abdomen is black usually with metallic greenish or bluish reflections at least in the male. In *guamensis* the basal abdominal segments are usually dark brown. *Yapensis* also is more extensively maculated with yellow than in the other species, the female having yellow spots on the clypeus, mesonotum and axillae which are lacking in *guamensis* and *hirticaudus,* the only other species in which the female is known. The mesonotal punctation in the series of *yapensis* before me is contiguous for the most part, whereas in *guamensis* it is much sparser, most of the punctures except anteriorly and along the margins separated by almost the width of a puncture.

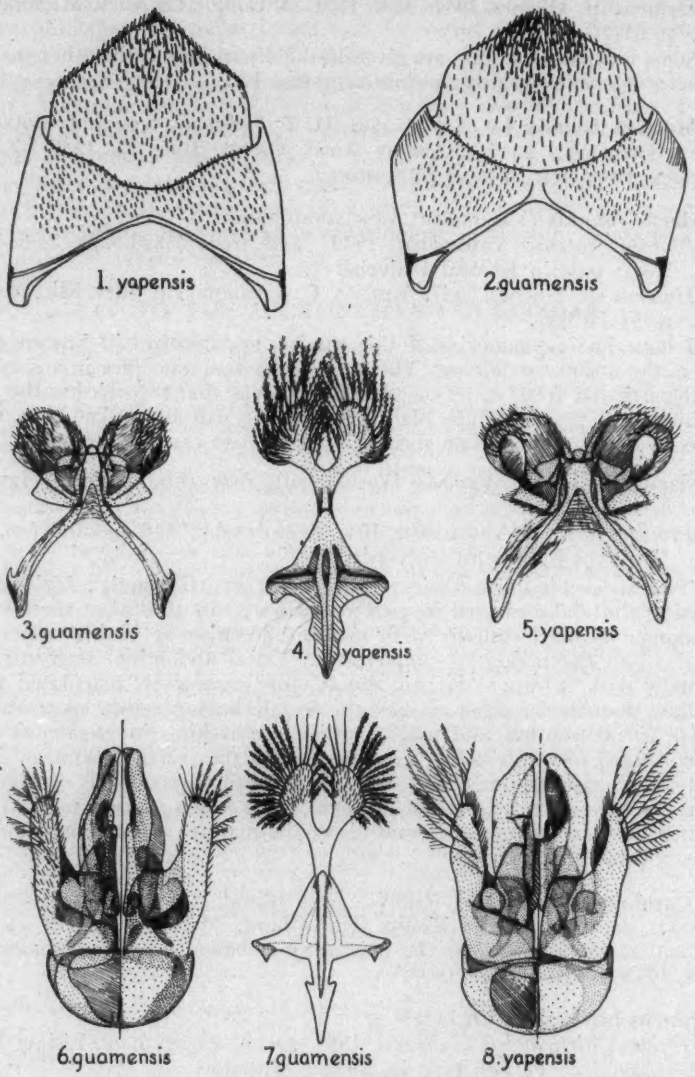
Caroline Islands: 1 ♀; Rul-Nif, Yap Island; September 8, 1939 (T. Esaki; paratype). 1 ♀; Rumu, Yap Island; March 1-8, 1949 (K. L. Maehler; visiting flowers). 1 ♂; Yaptown (labeled Colonia), Yap; March 1-8, 1949 (K. L. Maehler).

Hylaeus hirticaudus Cockerell

Hylaeus hirticaudus Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:66 [♂; Palaus; type in Bishop Museum].

Hylaeus sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Palaus].

This species too is known in the male sex only from the unique type which I have been unable to study. Comparison of specimens of *guamen-*



HYLAEUS MALES. Fig. 1, H. yapensis, 6th sternite; **fig. 2, H. guamensis,** 6th sternite; **fig. 3, H. guamensis,** 8th sternite; **fig. 4, H. yapensis,** 7th sternite; **fig. 5, H. yapensis,** 8th sternite; **fig. 6, H. guamensis,** genitalia; **fig. 7, H. guamensis,** 7th sternite; **fig. 8, H. yapensis,** genitalia. (All figures drawn by Miss Addie M. Egbert, Bureau of Entomology and Plant Quarantine.)

sis with the original description of *hirticaudus* indicates only the slight differences used in the foregoing key. Undoubtedly there are other differences though none is apparent from the description.

The following brief notes will serve to distinguish the hitherto unknown female: Length 7-9 mm.; black, scape of antenna and legs in varying degrees ferruginous, anterior abdominal segments sometimes brownish, and with the following yellow markings—band along inner eye margin narrowing above to slightly above level of antennal insertions, pronotal collar except narrowly in middle, pronotal tubercle, band on posterior half or two-thirds of disk of scutellum, and band on postscutellum almost equal in extent to that on scutellum. Structurally it is apparently closer to *yapensis* than to the other Micronesian species as evidenced by the produced pronotal collar, but differs in the deeper notch in middle of pronotal collar and the coarser but relatively sparser punctation on mesoscutum.

Caroline Islands: 9 ♀ ♀; east coast of Peleliu Island, Palaus; January 26, 1948 (H. S. Dybas; one female and a pupa found in log).

FAMILY HALICTIDAE

These small bees occur in rather large numbers of individuals in Micronesia and apparently visit flowers of a great variety of plants to collect pollen. Townes, 1947, notes that with the exception of one species on Ulithi Atoll [*yapensis*], all halictids are restricted to the high islands where they occur in the native forests. He says further that they are usually difficult to find, but are often abundant in localized areas, and may occur in large numbers at coconut flowers. The larger species belonging to the subgenus *Homalictus* Cockerell have a rather restricted range, but the smallest one, *yapensis* Cockerell of the subgenus *Indohalictus* Blüthgen, has a very wide range throughout the Carolines and shows an incipient tendency toward the development of island races.

All species have strong metallic reflections on head and thorax and strong to indistinct metallic reflections on the abdomen. All females have a well-developed functional scopa on the venter of the abdomen as well as the normal (for the family) one on the hind legs, the former composed of very dense, shorter hairs plumose almost to the base on the lateral incurved sides of the first to fourth tergites, a brush of similar hairs at base of first sternite, and transverse rows of sparser, longer hairs plumose only on the apical half across the middle of the second to fourth sternites.

Species of this genus and *Trigona* in the Apidae frequently show considerable variation in color of the abdomen, this varying from reddish to dark brown, or black. In *Trigona* this paler coloration has been associated with a callow state, and it seems reasonable to suppose that the variation in certain *Halictus* is also due to the presence in normal populations of a certain number of immature individuals.

KEY TO THE MICRONESIAN HALICTIDAE

1. Front between antennal fossae without longitudinal carina; pronotum with a sharp crest laterally, but not dentate; scutum and scutellum dull, granulate-appearing due to excessively fine lineolation, punctation obsolescent; front, vertex and temples not with close parallel rugulae or striae (fig. 17); male gonocoxite (fig. 9) with a large, thin, fan-shaped accessory process on inner edge at apex; Carolines (Ponape, Truk, Ulithi, Yap, Palaus)..... **Halictus (Indohalictus) yapensis** Cockerell, p. 111

   Front between antennal fossae with a longitudinal carina of varying lengths (occasionally evanescent in males of *saffordi* and *rotaënsis*); pronotum with an acute or obtuse tooth laterally (best seen when viewed from anteriorly); scutum and scutellum more or less shining, or at least not so strongly lineolate as in *yapensis*, and with discernible punctures; front, vertex and temples, one or all, with close parallel rugulae or striae (fig. 16); gonocoxite with accessory process absent, or if present (*rotaënsis* and *saffordi*) very small..... 2

2. Dorsum of propodeum shining, the sculpture consisting of close, moderate to strong rugulae radiating from base, or oblique and meeting along midline to form broad arches, in either case usually extending to apex of dorsal surface..... 3

   Dorsum of propodeum shining or dull and granulate, if shining the sculpture consisting of fine rugulae anastomosing to form irregular reticulations, if dull and granulate the sculpture consisting of sparse, short, radiating rugulae not extending to apex..... 4

3. Dorsum of abdomen in both sexes semi-mat, dark blue, the entire surface including depressed apical areas with dense short, dark brown hair except for narrow white bands of hair at base; front with close longitudinal rugulae, vertex with transverse rugulae; genitalia (fig. 12) with volsellae normal, tapering gradually to tip and without a patch of tubercles along outer margin; Carolines (Palaus, Yap—?)..... **Halictus (Homalictus) palaonicus** Cockerell, p. 113

   Abdomen red to dark brown in male (female unknown), the dorsum with dark green reflections and with much sparser, longer, dark hairs, the depressed apical areas nude; front granulate, vertex with transverse striae; genitalia (fig. 14) with volsellae greatly expanded at apex and with a patch of short stout tubercles on outer margin; Carolines (Yap)..... **Halictus (Homalictus) nummatus,** new species, p. 114

4. Vertex with only fine transverse striae, the rugulae obsolescent or absent; pronotum with an acute lateral tooth; dorsum of propodeum dull and appearing granulate from the coarse lineolation, the rugulae rather sparse, short, radiating, almost never anastomosing to any extent; abdomen of female with only feeble metallic reflections; seventh sternite of male (figs. 10, 11) with a large median lobe on apical margin, gonocoxite with a small accessory process, gonostylus rounded at tip..... 5

   Vertex with coarse transverse rugulae; pronotum with lateral tooth right-angled or obtuse; dorsum of propodeum shining, not granulate, the rugulae more numerous and forming a network of irregular reticulations; abdomen of female with strong metallic reflections; seventh sternite of male (fig. 13) narrow throughout, gonocoxite without an accessory process, gonostylus pointed at tip 7

5. Apical impunctate area of first to fourth tergites testaceous, forming a marked contrast to the castaneous, sparsely punctate anterior area; scutellum of female dull, the interspaces between punctures lineolate; male unknown; Marianas (Agrihan)..... **Halictus (Homalictus) vexator,** new species, p. 117

   Apical impunctate area of first to fourth tergites concolorous with anterior punctate areas, dark brown or bluish; females with the interspaces between punctures on disk of scutellum glossy, lineolation absent except along edges..... 6

6. Mesoscutum with the interspaces between punctures rather dull from excessive delicate lineolation, the punctures themselves, especially in the male, difficult to discern because of the roughened surface; upper half of front irregularly roughened; apical margin of clypeus with the angles not at all prominent; second to fifth sternites of male with sparse scattered hairs on apical half; man-

dible of male normal in shape, more or less falciform; male seventh sternite with the apical lobe triangular, genitalia as figured (fig. 11); Marianas (Rota, Tinian)..... **Halictus (Homalictus) rotaensis** Cockerell, p. 116

Mesoscutum with the interspaces shining, lineolation obsolescent or lacking, the punctures well-defined; upper half of front with longitudinal rugulae; apical margin of clypeus with angles very prominent; second to fifth sternites of male with dense bands of hair on apical half; mandible of male very broad on basal three-fourths (fig. 15); male seventh sternite with apical lobe broadly rounded, genitalia as figured (fig. 10); Marianas (Guam)..... **Halictus (Homalictus) saffordi** Cockerell, p. 117

7. Upper half of front with close longitudinal rugulae (fig. 16); basal tubercle on labrum of female deeply sulcate; lateral angles of apical margin of clypeus of female protruding, very prominent; male with tibiae usually red, occasionally the tarsi also, the rest of legs and antennal scape black; male genitalia as figured (fig. 13); Marianas (Guam, Rota, Saipan)..... **Halictus (Homalictus) swezeyi** Cockerell, p. 116

Upper half of front granulate; basal tubercle on labrum of female not sulcate; lateral angles of apical margin of clypeus of female not protruding; male with antennal scape and legs entirely red; Carolines (Kusaie, Ponape)..... **Halictus (Homalictus) auriger,** new species, p. 115

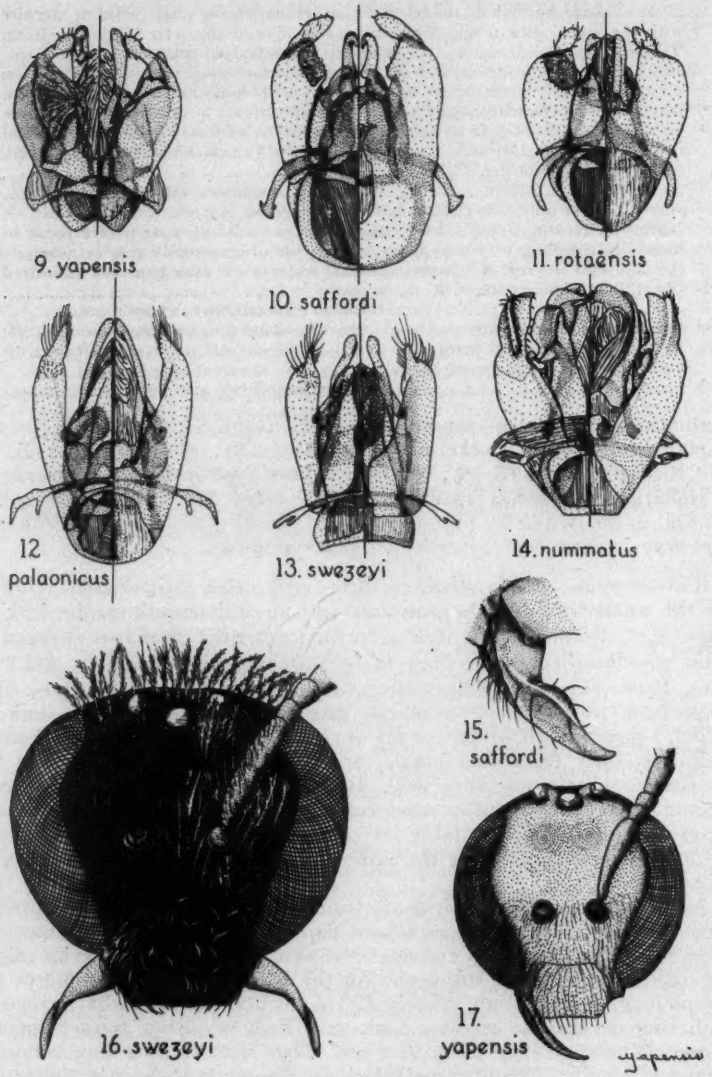
Halictus (Indohalictus) yapensis Cockerell (Figs. 9, 17)

Halictus yapensis Cockerell, 1939 (May 29). Occas. Papers B. P. Bishop Mus. 15:65 [♀, ♂; Yap, Palaus; type in Bishop Museum].

Halictus carolinensis Yasumatsu, 1939 (May 31). Tenthredo 2:332, pl. 9, fig. 1, pl. 10, figs. 4, 5, pl. 11, fig. 10 [♀, ♂; Truk, Ponape; type in Kyushu University]. **New synonymy.**

This species, readily distinguished from other Micronesian *Halicti* by the small size, densely granulate scutum and scutellum, the lack of rugulae on head, and the lack of an interantennal carina, is apparently most closely allied to the New Hebridean *zingowli* Cheesman and Perkins, 1939 (Feb. 28). The male genitalia are identical with those of a male from the Santa Cruz Islands just east of the southern Solomons which I have identified tentatively as *zingowli*. The latter form is known definitely only from the female, and the description of that sex fits specimens of *yapensis* very well, differing only in some minor details of the propodeal sculpture and color. When adequate series of both sexes of *zingowli* are available for comparison with a series of *yapensis*, it may be established that the latter should be treated as a subspecies of *zingowli*.

My specimens of *yapensis* come from Yap, Ulithi, Truk and Ponape. Cockerell described the species from Yap and the Palaus and Yasumatsu from Truk and Ponape. I thought at first that the Ulithi series might be treated as a discrete subspecies for the sculpture of the dorsum of the propodeum is made up principally of regular to somewhat irregular radiating or oblique rugulae with very little tendency toward anastomoses. The specimens from Yap and Truk usually have anastomosing rugulae forming irregular reticulations, though occasionally the sculpture is made up of only irregular oblique rugulae. The specimens from Yap and Ponape usually have these rugulae forming irregular reticulations at the base with oblique rugulae extending from this basal area, but several females exhibit the Ulithi type of sculpture. The specimens



HALICTUS MALES. **Figs. 9-14,** genitalia and seventh sternite; **fig. 9, H. yapensis; fig. 10, saffordi; fig. 11, H. rotaënsis; fig. 12, H. palaonicus; fig. 13, H. swezeyi; fig. 14, H. nummatus; fig. 15, H. saffordi,** mandible; **fig. 16, H. swezeyi,** head; **fig. 17, H. yapensis,** head.

from Truk have more of this area irregularly reticulate and somewhat more strongly so than in the Yap specimens, but again there are some specimens exhibiting the Ulithi type of sculpture. The Yap females, except two specimens, have the exposed parts of the fourth and fifth tergites reddish, whereas the other two females from Yap and all those from Truk and Ulithi have the basal two-thirds of the fourth dark brown, the apical third of the fourth and most of the fifth reddish. The Ponape females have most of the abdomen reddish, but in several specimens it is dark olive brown. No differences were found in the male genitalia of specimens from the three groups of islands from which I have seen males.

There is, perhaps, an incipient tendency toward development of separate subspecies on these island groups, but this has not yet progressed far enough to permit one to distinguish all specimens with any certainty. Continued isolation of the separate stocks may eventually result in the establishment of separate races showing no such intergradation of characters as noted above.

Dr. Yasumatsu has confirmed the synonymy given under the specific heading by comparison of specimens sent him with the type in the collection of Kyushu University.

Caroline Islands: 1 ♀; Jokaj Island, Ponape; February 26, 1948 (H. S. Dybas). 2 ♀ ♀; Nanpil, Nett Distr., Ponape; March 14, 1948 (H. S. Dybas). 26 ♀ ♀; Colonia, Ponape; March 6, 1948 (H. S. Dybas; on palm blossom, *Chyophorba amaricum*, at Expt. Sta.). 14 ♀ ♀; Udet Island, Truk Atoll; May 25, 1946 (R. G. Oakley; at seashore visiting coconut flowers). 1 ♀; same data, but collected by H. K. Townes. 2 ♀ ♀; Pis Island, Truk Atoll; June 3, 1946 (H. K. Townes). 1 ♀; Moen Island, Truk Atoll; May 23, 1946 (H. K. Townes; 0-400 ft. elev.). 2 ♀ ♀; same data, but June 1, 1946. 2 ♀ ♀; same data, but January 6-15, 1949 (M. M. Ross). 2 ♂ ♂; Dublon Island, Truk Atoll; May 28, 1946 (H. K. Townes; 1000-1200 ft. elev.). 4 ♀ ♀; same data, but February 12, 1948 (K. L. Maehler; on *Crotalaria*). 1 ♀; Mt. Uiniböt, Tol Island, Truk Atoll; May 24, 1946 (H. K. Townes). 1 ♂; Yap Island; May 21, 1936 (Z. Ono; cotype of *yapensis*). 1 ♀, 2 ♂ ♂; Yap Island (Z. Ono; cotypes of *yapensis*). 3 ♀ ♀; Yaptown, Yap Island; July 13, 1946 (H. K. Townes). 21 ♂ ♂; Fassarai Island, Ulithi Atoll; July 10, 1946 (H. K. Townes; at dusk resting on fern leaves at base of coconut trees). 20 ♀ ♀; same data, but July 11, 1946. 2 ♀ ♀; Potangeras Islet, Ulithi Atoll; November 10, 1947 (H. S. Dybas). Recorded also from the Palaus by Cockerell.

Halictus (Homalictus) palaonicus Cockerell (Fig. 12)

Halictus palaonicus Cockerell, 1939 (May 29). Occas. Papers B. P. Bishop Mus. 15:64 [♀, ♂; Palaus, Yap; type in Bishop Museum].

Halictus palauensis Yasumatsu, 1939 (May 31). Tenthredo 2:333, pl. 10, figs. 6, 7 [♀; Palaus; type in Kyushu University]. **New synonymy.**

This species is readily distinguished by the characters mentioned in the foregoing key. In addition the transverse rugulae on the vertex are stronger than in any of the other Micronesian *Halicti*. It is known only

from the western Carolines. The specimens recorded here from Yap are unquestionably *palaonicus,* though my opinion is that they may have been mislabeled as the species has not been taken since on Yap by other collectors, and species of this subgenus have a very restricted range.

Dr. Yasumatsu has confirmed the synonymy given above by comparison of specimens sent him with the type in the collection of Kyushu University.

Caroline Islands: 2 ♀ ♀; Yap Island (Z. Ono; cotypes of *palaonicus*). 3 ♀ ♀, 2 ♂ ♂; Palaus; April 5, 1936 (Z. Ono; cotypes of *palaonicus*). 6 ♀ ♀, 27 ♂ ♂; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). 4 ♀ ♀; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler; on *Ipomoea* flowers and burrowing in bark). 1 ♀; same data, but November 21, 1947 (H. S. Dybas). 1 ♀; Peleliu Island, Palaus; July 30, 1945 (H. S. Dybas) [CNHM]. 10 ♀ ♀, 4 ♂ ♂; Ulimang, Babelthuap Island, Palaus; December 11, 1947 (H. S. Dybas; around flowering shrub). 2 ♂ ♂; same data, but December 22, 1947.

Halictus (Homalictus) nummatus, new species (Fig. 14)

While this species appears to be most closely related to *palaonicus* among the Micronesian *Halicti,* it is quite distinct as may be seen by reference to the key, the following description and the illustrations of the male genitalia. The female is unknown, but should differ from *palaonicus* females in being relatively much more weakly sculptured and in having a shining rather than a semi-mat abdominal dorsum.

Type: ♂; Gorror, Yap; March 1-8, 1949 (K. L. Maehler; visiting flowers of unidentified plant). [U. S. National Museum, Type No. 59395.]

Male.—Length 6.7 mm., forewing 4.9 mm. Head and thorax bright golden green, the abdomen above dark brown with dark green reflections, beneath reddish; base of antennal scape and flagellum beneath ferruginous, antennae elsewhere dark brown; fore femora and all tibiae and tarsi ferruginous except hind tibia above, legs elsewhere dark brown with green reflections. Vestiture of head and thorax whitish to creamy, rather dense on front, head beneath and sides of thorax, very sparse on dorsum of thorax; on abdomen the hair dark, short, sparse and appressed on dorsum, longer on sides and at apex, the broad depressed apical margins of tergites nude. Wings hyaline, veins dark brown.

Head rather dull from surface sculpture, rounded in frontal aspect, the height (from posterior ocelli to apex of clypeus) less than greatest width (10:12); clypeus nearly flat (strongly protuberant in *palaonicus*) with apical margin truncate, lateral angles not protuberant, twice as broad as high, surface of clypeus and supraclypeal area densely lineolate, the former with scattered large punctures, the latter practically impunctate (both areas with lineolation practically absent in *palaonicus*); frontal carina as in *palaonicus,* strong and extending from base of supraclypeal area half-way to anterior ocellus; front granulate, punctures not discernible; vertex and temples with close striae, transverse on vertex, longitudinal on temples.

Thorax shining; pronotal tooth obtuse, not at all prominent; scutum with very delicate lineolation and a few scattered, small punctures; scutellum not at all lineolate, the punctures more numerous; postscutellum more strongly lineolate than scutum, the vestiture denser, but punctures not discernible; dorsum of propodeum with close radiating rugulae, those in the center extending only two-thirds the length of disk, the surface delicately lineolate, carina separating lateral and posterior surfaces present on lower third only (complete in *palaonicus*); mesopleural sculpture much like that of scutum, but punctures denser, and transverse rugulae entirely lacking (present anteriorly in *palaonicus*).

Abdomen shining, though less so than thorax, the tergites with very delicate transverse striae, and with scattered small punctures on areas basad of depressed apices; genitalia and seventh sternite as figured (fig. 14), the volsellae unique among Micronesian *Halicti* in being greatly expanded at the apex and with a patch of short, stout tubercles along outer margin.

Paratypes: 3 ♂ ♂; same data as type. 3 ♂ ♂; same data as type, but March 1, 1949 (K. L. Maehler; on unidentified plant). One male paratype will be deposited in the collection of the B. P. Bishop Museum, Honolulu, and one in Kyushu University, Fukuoka, Japan.

Male paratypes vary in length from 6.2 to 7.2 mm. The color is much the same as in the type, except that in some specimens the abdomen may be almost entirely red, and the legs may vary to entirely ferruginous. The sculpture is fairly uniform, the dorsum of the propodeum showing some variation in that some of the rugulae may be more oblique in position and may meet along the midline to form broad arches as in some specimens of *palaonicus*.

Halictus (Homalictus) auriger, new species

Halictus saffordi Cockerell, Yasumatsu, 1939. Tenthredo 2:331, figs. 8, 9, 11 [♀, ♂; Kusaie; misdetermination of Cockerell species].

This species is quite distinct from *saffordi* Cockerell, and is similar in coloration to the Samoan *perpessicus* Kohl, being the only Micronesian species, except for the distantly related *yapensis*, with brilliant golden-green reflections on the head and thorax. The female differs from *perpessicus* in the non-sulcate tubercle at the base of the labrum and the non-protruding lateral angles of the apical margin of the clypeus. I have not seen the male and it is included in the key on the basis of characters mentioned in Yasumatsu's brief descriptive notes. It is the only known Micronesian male with the scape of antenna and legs entirely ferruginous.

Type: ♀; Lele Island, Kusaie; August 19, 1946 (R. G. Oakley). [U. S. National Museum, Type No. 59396.]

Female.—Length 6.7 mm., forewing 4.6 mm. Head and thorax brilliant golden-green, the clypeus darker and metallic bluish green, the abdomen light brown with brassy reflections; antennal scape entirely, flagellum beneath, and legs, ferruginous. Vestiture of thorax moderately long on the sides, white, on scutum and dorsum of abdomen short, rather dense, creamy. Wings hyaline.

Head rounded in frontal aspect, the height (from posterior ocelli to apex of clypeus) slightly less than greatest width (10:11); process at base of labrum low and rounded, not sulcate; clypeus with apical margin truncate, the angles not prominent, surface sculpture of clypeus and supraclypeal area lineolate with scattered large punctures; frontal carina extending almost half the distance from base of supraclypeal area toward anterior ocellus; front closely rugulosopunctate; vertex and temples with close transverse rugulae, stronger than in *swezeyi*, the rugulae laterad of posterior ocelli oblique.

Thorax shining, the dorsum with scarcely any lineolation except anteriorly and laterally on scutum; pronotal tooth right-angled; scutum moderately densely punctate on anterior half and laterally, the scutellum more sparsely so; postscutellum rugulosoreticulate; dorsum of propodeum rugosoreticulate, much more coarsely so than in *swezeyi*, the center somewhat depressed, the rim rounded and not sculptured, carina separating lateral and posterior surfaces of propodeum only one-third the height; mesopleuron with close, fine transverse rugulae, stronger than in *swezeyi*.

Inner hind tibial spur with four teeth decreasing in length toward tip.

Basal four abdominal tergites with delicate transverse striae, apices broadly impunctate, the anterior parts with minute, moderately numerous punctures.

Paratype: ♀; Mt. Dolennankap, Ponape; August 13, 1946 (H. K. Townes; 1700-1900 ft. elev., in native rain forest). [U. S. National Museum.]

The paratype shows some variation, and a series including males from both islands might indicate that two separate forms are involved. However, a similar range of variation is seen in the Samoan *perpessicus,* so until additional material is available I prefer including the specimens available under one name. The paratype is larger (7.2 mm. long, forewing 5.0 mm.), ratio of head height to width somewhat different (10:10.5), the abdomen is darker brown but with brassy reflections, and only the femora and tibiae are ferruginous to some extent, the rest of the legs brown with brassy reflections.

Halictus (Homalictus) swezeyi Cockerell (Figs. 13, 16)

Halictus swezeyi Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:66 [♀; Guam; type in Bishop Museum; brief descr. in key only]. —Cockerell, 1942. B. P. Bishop Mus. Bul. 172:189 [♀, ♂; Guam; full descr.].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:191-3 [♀, ♂; Rota; in key to Pacific Island *Halicti*].

In structural details this seems rather closer to *auriger* than to any of the other Micronesian species, though it is readily distinguished by the key characters. The normal coloration appears to be dark brown or black with metallic green reflections in the female, while in the male the abdomen almost always is dark blue, and occasionally the thorax also. There is also variation in the color of the male legs which vary from entirely dark with green reflections to forms having the tibiae and tarsi, or tibiae only, ferruginous.

Mariana Islands: 1♀, 1♂; Santa Rosa Peak, Guam; May 19, 1936 (R. L. Usinger; cotypes of *swezeyi*). 1♂; same data, but labeled *swezeyi* var. by Cockerell. 7♀♀, 1♂; Ritidian Point, Guam; June 1945 (J. L. Gressitt). 2♂♂; Agricultural Farm, Guam; May 15, 1948 (K. L. Maehler). 1♂; Ylig, Guam; December 14, 1947 (K. L. Maehler; on *Scaevola*). 12♂♂; Asan, Guam; January 31, 1948 (K. L. Maehler; visiting citrus). 17♀♀, 9♂♂; Talofofo, Guam; July 1, 1946 (R. G. Oakley; on coconut flowers). 2♀♀; same locality, but December 20, 1947 (K. L. Maehler). 1♂; Haputo Point, Guam; April 29, 1948 (K. L. Maehler; on Chinese inkberry). 3♀♀, 1♂; Point Oca, Guam; June 1945 (J. L. Gressitt and G. E. Bohart). 1♂; same data, but June 2, 1945 (H. S. Dybas) [CNHM]. 4♀♀, 5♂♂; Merizo, Guam; June 11, 1936 (R. L. Usinger). 1♀; same locality, but December 18, 1947 (K. L. Maehler). 4♀♀; Rota; July 23, 1925 (Hornbostel). 1♀; Rota; June 26, 1946 (R. G. Oakley). 3♀♀; Saipan; January 1, 1948 (K. L. Maehler).

Halictus (Homalictus) rotaënsis Cockerell (Fig. 11)

Halictus rotaënsis Cockerell, 1942. B. P. Bishop Mus. Bul. 172:191 [♀; Rota; type in Bishop Museum].

? Halictus rotaënsis var. *hornbosteli* Cockerell, 1942. B. P. Bishop Mus. Bul. 172:191 [♀; Rota; type in Bishop Museum].

The clypeus of the females of the Tinian series recorded below is less strongly lineolate than in Rota females, but due to the absence of males from Rota, I prefer placing them all under typical *rotaënsis* for the time being. Differences in the males, if there are any, would suggest the desirability of recognizing two subspecies. Typically the head and thorax are dark with greenish reflections, the abdomen brown of varying shades and with obscure metallic reflections. The variety *hornbosteli* Cockerell is separated by having the clypeus and supraclypeal area with rosy tints, and the mesonotum and scutellum rosy pink. I have seen no specimens with this coloration, and do not know whether it should be recognized as a distinctive form or placed in the synonymy as just a chance variation.

Mariana Islands: 1 ♀; Rota; July 26, 1925 (Hornbostel; cotype). 1 ♀; same data, but June 27, 1946 (R. G. Oakley; on *Oscillita*). 1 ♀; Shinaparu, Rota; June 24, 1946 (H. K. Townes). 8 ♀ ♀, 12 ♂ ♂; Mt. Lasso, Tinian; June 12, 1946 (H. K. Townes).

Halictus (Homalictus) saffordi Cockerell (Figs. 10, 15)

Halictus sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:282 [Guam].
Halictus saffordi Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:2 [♀; Guam; type in U. S. National Museum].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:189 [♀, ♂; Guam localities].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:192-3 [in key to Pacific Island *Halicti*].

This is rather similar to *rotaënsis* in general coloration, though larger and with rather infumated wings in addition to the separation characters mentioned in the key. The mandible of the male is very unusual, and not at all like any other Micronesian species, but the genitalia show the species to be rather close to *rotaënsis*.

Mariana Islands: 3 ♀ ♀; Guam (D. T. Fullaway; type and cotypes). 3 ♀ ♀, 1 ♂; Guam; 1937 (R. G. Oakley). 37 ♀ ♀, 2 ♂ ♂; Talofofo, Guam; July 1, 1945 (R. G. Oakley; on coconut flowers). 5 ♀ ♀; same data, but February 26, 1948 (K. L. Maehler). 2 ♀ ♀; Talofofo Bay, Guam; January 25, 1948 (K. L. Maehler; on *Scaevola*). 3 ♀ ♀; Merizo, Guam; December 18, 1947 (K. L. Maehler; on *Scaevola*). 1 ♀; Mt. Santa Rosa, Guam; June 1945 (J. L. Gressitt and G. E. Bohart). 1 ♀; Tumon Bay, Guam; April 27, 1948 (K. L. Maehler; on coconut flower). 1 ♂; Piti, Guam; October 29, 1936 (O. H. Swezey). 1 ♀; Barrigada, Guam; June 24, 1936 (O. H. Swezey; on corn).

Halictus (Homalictus) vexator, new species

This is obviously rather closely related to two other species occurring in the Marianas, *saffordi* and *rotaënsis*. It is readily distinguished from them by the very strong lineolations of the scutum and scutellum. The pallid posterior margins of the first four tergites are also distinctive, but my specimens appear to be callows, and it may be that fully mature individuals would not show the marked contrast in coloration of the tergites exhibited by them.

Type: ♀; Agrihan, Marianas; July 29, 1945 (Borror and Holder). [U. S. National Museum, Type No. 59397.]

Female.—6.1 mm. long, forewing 4.6 mm. Head and thorax dark, with metallic blue and green reflections, dull; antennae and abdomen castaneous, the broad apical margins of the first to fourth tergites pallid; tegulae, femora, tibiae and tarsi ferruginous; pubescence of head and thorax short, grayish, not obscuring the sculpture.

Head rounded in frontal aspect, the height from posterior ocelli to apex of clypeus equal to greatest width; clypeus with apical margin truncate, the angles moderately prominent, the surface lineolate and with scattered punctures; process at base of labrum narrow, sulcate in middle; supraclypeal area more minutely lineolate and duller than clypeus, and with scattered punctures; front closely rugulosoreticulate, frontal carina very short; almost evanescent; vertex with fine close transverse striae; temples with some fine longitudinal rugulae.

Thorax dull from strong lineolation; pronotal tooth acute; scutum densely lineolate, the punctures also rather dense and for the most part separated by about the width of a puncture; scutellum with the punctures denser; postscutellum with punctation obscure, the punctures much smaller than on scutellum; dorsum of propodeum densely granulate and with irregular, sparse rugae radiating from base about three-fourths the distance to summit; carina separating lateral and posterior surfaces of propodeum extending three-fourths the height of propodeum; mesopleuron on lower half with very fine, close transverse rugulae.

Inner hind tibial spur with four teeth decreasing in length toward tip.

First four abdominal tergites with dense, transverse striae, the anterior two-thirds of each with scattered small punctures, the broad, pallid posterior margins impunctate.

Paratype: ♀; Agrihan (D. J. Borror). [U. S. National Museum.]

FAMILY MEGACHILIDAE

This family is well represented in Micronesia though more than half the species are introduced. Many species of the genus *Megachile* are popularly called leaf-cutter bees because the females cut more or less circular pieces from leaves to construct cells for the young. Townes, 1947, notes that the various "species of *Megachile* are common on the atolls and on the coastal parts of high islands. Their leaf-cutting activity affects many species of plants whose leaves are not too thick and leathery, and often reaches serious proportions. Dead twigs of *Scaevola frutescens* are favorite nesting sites. Favorite flowers are those of *Triumfetta procumbens, Scaevola frutescens,* and *Wedelia biflora.* On high islands many other flowers are available and used."

KEY TO THE MICRONESIAN MEGACHILIDAE

1. Tarsi with an arolium between the claws; anterior declivous surface of first tergite separated from posterior horizontal surface by a strong transverse carina; small bees, not over 7 mm. in length.....**Heriades (Michenerella)** 2
   Tarsi without an arolium between the claws; first tergite without such a carina; larger forms, at least 8 mm. in length, and usually much more..... 3
2. Plumose pubescence of vertex, dorsum of thorax and last three tergites ochraceous; legs and abdomen brown. Female: upper edge of thickened apical margin of clypeus slightly crenulate; dorsal carina of mandible almost straight, present only on apical half. Male: mesonotum with some short, scattered, moss-like plumose hairs on disk as well as the dense ones along margins; apical margin of first sternite convex in middle; transverse sinuate flange across middle of fourth sternite (fig. 22) interrupted at midline, a strut-like thickening along midline between flange and base of sternite. Carolines (Palaus)..... .....**Heriades (Michenerella)) plumosa,** new species, p. 125

Plumose pubescence of these areas white to creamy; legs and abdomen black. Female: upper edge of thickened apical margin of clypeus not crenulate; dorsal carina of mandible present on apical two-thirds, curved strongly upwards about halfway to base. Male: disk of mesonotum with simple hairs, only the margins with short, plumose moss-like hairs; apical margin of first sternite slightly emarginate in middle; transverse sinuate flange across middle of fourth sternite not interrupted at midline, no strut-like thickening between flange and base of sternite. Marianas (Guam, Tinian, Saipan, Pagan)..... **Heriades (Michenerella) paganensis** Yasumatsu, p. 123

3. Tongue long, in repose reaching apex of first sternite; last visible tergite in both sexes with a very narrow pygidial plate; dorsum of mesonotum of female transversely and irregularly rugose anteriorly, punctate only along margins; male with six visible sternites clothed with dense, plumose, suberect hairs; Marianas, Carolines, general..... **Lithurgus (Lithurgus) scabrosus** (Smith), p. 120

Tongue in Micronesian species short, in repose not extending beyond apex of fore coxae; differentiated pygidial area absent; dorsum of mesonotum of female entirely punctate, except rugosopunctate laterally in *umbripennis;* male with only four visible sternites clothed with short decumbent hairs, sparse except for bands at apices..... **Megachile** 4

4. Females 5
Males 9

5. Second to fifth sternites with narrow apical bands of pale tomentum beneath the scopa; scopa white on second, fulvous on remaining sternites except at apex of sixth where it is black; face, sides of head and thorax with pure white hair; Marshalls, Marianas, Carolines, general..... **Megachile (Eutricharaea) fullawayi** Cockerell, p. 126

Sternites without such bands at apices; scopa colored differently; pubescence of head and thorax never pure white..... 6

6. Mandibles without a straight cutting edge between any teeth, the margins between the second, third and fourth (innermost) teeth concave; dorsum of thorax and first tergite with dense, short, appressed, bright fulvous hair; sides of mesonotum and much of mesopleuron closely and coarsely rugosopunctate; apical two-thirds of wings strongly infuscate; scopa whitish except at apex of fifth sternite and all of sixth where it is black, the pale hairs slightly capitate at tips; Marianas (Saipan).... **Megachile (Eumegachile) umbripennis** Smith, p. 125

Mandibles with a straight cutting edge (thin septum) between the second and third and third and fourth teeth; dorsum of thorax and first tergite with most of hair longer, finer, sparser and not appressed, never bright fulvous; sides of mesonotum and mesopleuron closely punctate, not at all rugose; wings never more than slightly infumated; scopa differently colored and pale hairs not capitate at tips 7

7. Tergites with extremely fine dense punctures, no large impunctate areas present; scopa bright fulvous except on last sternite where it is black; Marshalls (general), Carolines (Murilo Atoll)..... **Megachile diligens hedleyi** Rainbow, p. 130

Tergites with larger, more scattered punctures and with large impunctate areas on third to fifth tergites; scopa not colored as above..... 8

8. Median half of apical margin of clypeus shallowly concave; narrow apical bands of second to fifth tergites white; scopa pale whitish except black laterally on fifth and entirely on sixth sternites, the fifth occasionally tending toward pale fulvous; erect hair on dorsum of thorax pale fulvous; Marianas, Carolines, general..... **Megachile láticeps** Smith, p. 127

Only the median third of apical margin of clypeus shallowly concave; narrow apical bands of second to fifth tergites fulvous; scopa fulvous except sides of third and fourth, and fifth and sixth sternites entirely where it is black; erect hair on dorsum of thorax dark except on margins; Carolines (Palaus)..... **Megachile palaonica** Cockerell, p. 129

9. Fore coxa with a small tooth (*umbripennis*) or process beneath near apex; mandible at tip tridentate, with a basal or subbasal tooth on inferior margin

except in *umbripennis* which has dense, bright fulvous hair on dorsum of thorax and first tergite..... 10

Fore coxa unarmed; mandible at tip quadridentate, and without a tooth on inferior margin at or near base..... 12

10. Fore basitarsus concave beneath, spirally twisted, the anterior margin abruptly narrowed about two-thirds the distance to apex; mandible on inferior margin with a moderate-size subbasal tooth; carina (not morphological apical margin) of sixth tergite irregularly crenulate, not deeply and broadly emarginate in middle; Marianas, Carolines, general..... **Megachile (Eutricharaea) fullawayi** Cockerell, p. 126

Fore basitarsus not concave beneath or spirally twisted; mandible on inferior margin unarmed (*umbripennis*) or with a large basal tooth (*diligens hedleyi*); carina of sixth tergite not irregularly crenulate..... 11

11. Apical two-thirds of wings deeply infuscate; dorsum of thorax and first tergite with short, dense, bright fulvous pubescence; carina of sixth tergite broadly rounded, very shallowly emarginate in middle and not dentate on either side of emargination; fore tarsus black, not widened; Marianas (Saipan)..... **Megachile (Eumegachile) umbripennis** Smith, p. 125

Wings only slightly infumate on apical fourth; dorsum of thorax and first tergite with longer whitish hairs, those on mesonotum with some dark ones intermixed on disk; carina of sixth tergite semicircularly emarginate in middle and with a strong tooth on each side of emargination; fore tarsus reddish to fulvous, flattened and wide, the basitarsus about three times the width of the apical segment; Marshalls (general), Carolines (Murilo Atoll)..... **Megachile diligens hedleyi** Rainbow, p. 130

12. Clypeus with pubescence so dense that basic punctation is not visible; apical bands on second to fifth tergites white; sixth tergite black, with sparser fulvous tomentum, the carina emarginate in middle, but not so deeply and without a large tooth on each side of emargination; tarsi with fringes of long, slightly curled hairs, those of fore and mid tarsi on posterior margins, and those of hind tarsi on anterior margin; Marianas, Carolines, general..... **Megachile laticeps** Smith, p. 127

Clypeus with pubescence sparser on basal half, not obscuring the basic punctation; apical bands on second to fifth tergites light fulvous to almost golden; sixth tergite red, with dense golden tomentum, the carina semicircularly and more deeply emarginate in middle and with a large tooth on each side of emargination; tarsi with the fringes of hair normal in length, much shorter and straight; Carolines (Palaus)..... **Megachile palaonica** Cockerell, p. 129

Lithurgus (Lithurgus) scabrosus (Smith)

Megachile scabrosus Smith, 1859. Jour. Proc. Linn. Soc. 3:134 [♀; Aru Island; type in Hope Museum, Oxford University].

Lithurgus albo-fimbriatus Sichel, 1867. Reise Novara, Zool. 2:151 [♀; Tahiti; type in Vienna Hofmuseum].

Lithurgus sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:282 [Guam].

Lithurgus guamensis Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:1 [♀; Guam; type in U. S. National Museum].—Yasumatsu, 1939. Tenthredo 2:333, figs. 19, 20 [♀, ♂; Saipan, Kusaie, Ponape, Truk, Palaus].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:189. **New synonymy.**

Lithurgus albofimbriatus froggatti Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:469 [♀; New Hebrides; type in U. S. National Museum].

Lithurgus scabrosus froggatti Cockerell, 1929. Rec. Austral. Mus. 17:233 [*froggatti* transferred as subspecies of *albofimbriatus* to *scabrosus*].

Lithurgus scabrosus (Smith), Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:64 [♀; Yap, Palaus, Ponape].

Perkins and Cheesman, 1928 (Ins. Samoa, Hym., Pt. 5, Fasc. 1:10), after studying Smith's type concluded that it was identical with specimens from Samoa, Fiji, Rarotonga, Society Islands, Marquesas and Hawaii. Kohl, 1908 (Denkschr. K. Akad. Wiss. Wien, Math.-Naturw. Kl. 81:308), had previously found that specimens from Samoa were identical with Sichel's type, so Perkins and Cheesman placed *albo-fimbriatus* in synonymy. Cheesman, 1936 (Trans. Roy. Ent. Soc. 85:172), synonymized *albofimbriatus froggatti* under *scabrosus*.

After a study of some hundred-odd specimens from various of the Pacific islands, I am convinced that only one rather variable species is involved, except for the Solomon Islands *fortis* Cockerell which appears to be constantly distinct. I cannot well suppose that the male Samoan *bractipes* Perkins and Cheesman is anything but the male of *scabrosus* (they record only females of *scabrosus* from Samoa). I am able to confirm the synonymy of *albofimbriatus froggatti* by examination of the type. The dense hair at apex of sixth tergite in females ranges from black through brown to bright red, and series from one island may show all stages of variation.

Females may or may not have a median groove on the scutellum which is subject to some variation in development, though apparently always absent in Micronesian specimens; only one of the males before me has a feeble indication of such a groove. Micronesian females have the space between clypeus and frontal ridge punctate, whereas other females tend to have this space impunctate; however, Micronesian males are variable in this character, some having the ridge continuous to base of clypeus and others with an intervening punctate area. The variability is very marked in the male eighth sternite which in no two specimens is quite identical in shape or arrangement and number of apical setae. In fact, there is even variation in the setal arrangement on the two sides of one specimen. In the two males from the Carolines the narrow basal part of the eighth sternite is more slender and longer than in others. Unfortunately, I do not have adequate series of males from any one locality so I am unable to state whether specimens from one island might show more constancy in the shape of this sternite.

When I wrote Dr. Yasumatsu of my conclusions as to the variability of this species, he replied that he agreed with my treatment of all Micronesian material as *scabrosus*, and stated further that he was unable to separate the Japanese *collaris* Smith, 1873, from Micronesian material of *scabrosus*.

Cheesman, 1932 ("Hunting Insects in the South Seas," pp. 125-130), records *scabrosus* in the New Hebrides as nesting in deserted beetle burrows in dry posts and in canes. This habit would undoubtedly facilitate dispersion of the species from island to island.

Mariana Islands: 2 ♀ ♀; Guam (D. T. Fullaway; type and cotype of *guamensis*). 1 ♀; Machanao, Guam; June 30, 1936 (R. L. Usinger). 1 ♀; Santa Rita, Guam; January 29, 1949 (K. L. Maehler; on *Ipomoea*). 1 ♀; Guam; 1937 (R. G. Oakley). 1 ♂; Tinian; June 8, 1946 (H. K. Townes). 1 ♀; Charan Kanoa, Saipan; May 11, 1940 (Yasumatsu and Yoshimura)

[KU]. 1 ♀; Garapan, Saipan; December 20, 1944 (H. S. Dybas) [CNHM]. 1 ♂; Susupe Lake, Saipan; January 13, 1949 (K. L. Maehler). 1 ♂; Fanagam, Saipan; May 12, 1940 (Yasumatsu and Yoshimura) [KU]. 2 ♂ ♂; 1-2 mi. E. of Tanapag, Saipan; November 21, 1944 (S. Edgar) [CNHM]. 1 ♀; same locality, but November 24, 1944 (H. S. Dybas) [CNHM]. 1 ♂; Agrihan; July 29, 1945 (Borror and Holder).

Caroline Islands: 4 ♀ ♀; Mwot-utwe, Kusaie; December 12, 1937 (T. Esaki) [KU]. 1 ♀; Pouneran-Neipip, Ponape; February 24, 1936 (Z. Ono; det. as *scabrosus* by Cockerell). 2 ♀ ♀; Colonia-Sankakuyama; July 14, 1939 (T. Esaki) [KU]. 2 ♂ ♂; Moen Island, Truk Atoll; February 6, 1948 (K. L. Maehler; on *Ipomoea*). 3 ♀ ♀; same locality, but March 1949 (D. Langford). 1 ♀; same locality, but February 19, 1948 (H. S. Dybas). 2 ♀ ♀; Sabote-Epin, Pata Island, Truk Atoll; April 10, 1940 (Yasumatsu and Yoshimura) [KU]. 1 ♀; Rul, Yap Island; November 13, 1939 (T. Esaki) [KU]. 1 ♂; Yaptown (labeled Colonia), Yap Island; March 1-8, 1949 (K. L. Maehler; on flowers of unidentified plant). 1 ♀; Palau Islands; April 8, 1936 (Z. Ono; det. as *scabrosus* by Cockerell). 1 ♂; Koror Island, Palaus; March 8, 1949 (K. L. Maehler). 1 ♂; same data, but March 15-25, 1948, on *Ipomoea*. 2 ♀ ♀; Ngarard-Ngarasumao, Babelthuap Island, Palaus; February 7, 1938 (T. Esaki) [KU]. 2 ♀ ♀; Ulimang, Babelthuap Island, Palaus; December 14, 1947 (H. S. Dybas). 1 ♀; same data, but December 24, 1947.

Heriades subgenus **Michenerella,**[2] new subgenus

Type of the subgenus: *Heriades paganensis* Yasumatsu.

The species assigned herein to this new subgenus have occupied a taxonomic no-man's land until this time. Michener, 1938 (Ann. Ent. Soc. Amer. 31:514-531, 26 figs.), in his classification of the American *Heriades,* was unable to assign them to a subgenus because he had the female of only one of the species. Yasumatsu, 1942 (Tenthredo 3:342-6, 2 figs.), in describing *paganensis,* suggested that it might belong to the New World subgenus *Neotrypetes* Robertson, but comparison of the retracted male sternites of *paganensis* and other species assignable to *Michenerella* with those of *Neotrypetes* shows that this suggested assignment is untenable.

This new subgenus is established for the Old World members of the genus which have rounded axillae as in the New World subgenera *Neotrypetes* and *Physostetha* Michener, rather than having the axillae produced into points as in the Old World subgenus *Heriades* Spinola. The species which I have seen that may be assigned definitely to *Michenerella,* are the Marianas *paganensis* Yasumatsu, the Palau *plumosa,* new species, the Philippine *sauteri philippinensis* (Friese) (as determined by Cockerell), the Bornean *fulvescens* Cockerell and *bakeri* Cockerell, and the Siamese *laosella* Cockerell. The subgenus is predominantly Oriental in distribution with fringe elements in Oceania and Egypt (*H. moricei*

[2] For C. D. Michener, whose research on the generic classification of the Osmiinae has established the basis for the subgeneric groupings in *Heriades.*

Friese, *fide* Michener). It is possible that it is the only subgenus occurring in the Oriental region, though I cannot say positively since I lack a number of the species described from that region. Unfortunately the original descriptions do not mention characters considered to be of subgeneric importance, and frequently are practically worthless for specific identification.

The combination of characters which serve to separate *Michenerella* from the other described subgenera are as follows (based on the forms mentioned above as definitely assignable to *Michenerella*): Axillae rounded; ♀ ♀—clypeal margin thickened but not denticulate or tuberculate or very weakly so, mandibular carinae separated except apically, crest of postscutellum developed on median third only and not interrupted at mid-line, hypostomal carinae high posteriorly and rather abruptly reduced; ♂ ♂—first sternite large, broadly rounded apically and almost totally concealing the second, the apex in middle slightly convex to slightly concave, fifth sternite with a narrow median emargination on apical margin as in *Neotrypetes*, sixth sternite with apical margin broadly rounded and with a median emargination, not subtriangular as in *Neotrypetes* and *Physostetha* or with a short, narrow projection as in *Heriades sens. str.*, the hairs along apical margin long, and with an oval or rounded area basad of emargination with very stout curved setae, genitalia with paramere gently curved inward toward apex and narrowing slightly toward apex, not abruptly incurved near apex nor slightly expanded into a bulb at tip.

Heriades (Michenerella) paganensis Yasumatsu

Eriades sp. Yasumatsu, 1940. Akitu 2:185 [Pagan Island, Marianas].
Heriades paganensis Yasumatsu, 1942. Tenthredo 3:342, figs. 4, 5 [♀, ♂; Pagan; type in Kyushu University].

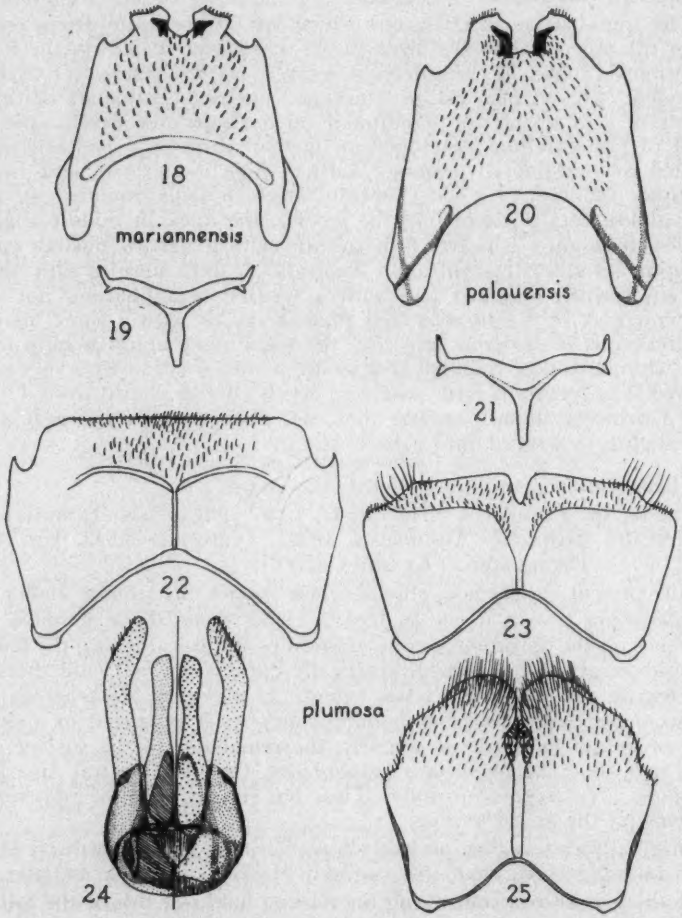
The present species and *plumosa*, new species, are unique among all *Michenerella* known to me in having rather dense discal plumose pubescence on the apical tergites in addition to the apical bands, the fourth to sixth tergites in the males practically entirely covered, and those in the female to a somewhat lesser extent. In all other *Michenerella* the plumose pubescence on the abdominal tergites is restricted to a single row of apical hairs except laterally, the remainder of the surface covered with short, inconspicuous simple hairs. Only the Central American *Heriades* (*Neotrypetes*) *bruneri* Titus has similar plumose pubescence on most of the apical tergites.

Originally this species probably was restricted to the northern Marianas for all records from the southern Marianas are 1945 or later.

Nothing is known concerning the nesting habits of this or the following species, but other members of the genus nest in twigs or posts, most likely in deserted beetle borings.

Mariana Islands: 1 ♀; Soñgsoñg, Pagan Island; April 26, 1940 (Yasumatsu and Yoshimura; paratype). 1 ♂; Civil Administration, Saipan; January 10, 1949 (K. L. Maehler; swept in field). 1 ♂; Tanapag, Saipan;

January 15, 1949 (K. L. Maehler). 1 ♀; Charan Kanoa, Saipan; January 2, 1948 (K. L. Maehler). 7 ♂ ♂; Tinian; June 9, 1946 (H. K. Townes). 1 ♀; Talofofo, Guam; February 2, 1948 (K. L. Maehler). 1 ♀; Amantes Point, Guam; May 27, 1945 (H. S. Dybas) [CNHM].



CERATINA AND HERIADES MALES. Fig. 18, C. mariannensis, 6th sternite; **fig. 19, C. mariannensis,** 7th sternite; **fig. 20, C. palauensis,** 6th sternite; **fig. 21, C. palauensis,** 7th sternite; **fig. 22, H. plumosa,** 4th sternite; **fig. 23, H. plumosa,** 5th sternite; **fig. 24, H. plumosa,** genitalia; **fig. 25, H. plumosa,** 6th sternite.

Heriades (Michenerella) plumosa, new species (Figs. 22-25)

The present species, though similar to *paganensis,* may be distinguished readily by the characters listed in the foregoing key, as well as by additional minute characters in the hidden sternites and genitalia. In *plumosa* the oval setose area of the sixth sternite bears larger and denser setae, while the hairs at the apex are somewhat finer. The genitalia are practically identical though *plumosa* has shorter setae along inner margin of gonoforceps about two-thirds the distance from base. Also, in *plumosa* the apical edge of the clypeus of the male is not quite so thickened as in *paganensis.*

Type: ♂; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes). [U. S. National Museum, Type No. 59398.]

Male.—5.6 mm. long, forewing 3.6 mm. Black; tegulae, legs and abdomen brownish; pubescence on dorsum of head, thorax and fourth to sixth tergites of abdomen ochraceous, on sides, venter, legs and first three tergites creamy; pubescence of mesonotum rather uniform in character, plumose, moss-like, denser along margins than discally, fourth to sixth tergites with moderately dense, appressed, short plumose hairs anterior to the apical bands, the apical bands on the first five tergites composed of several rows of short, dense, appressed plumose hairs.

Labrum with a transverse ridge near base interrupted in middle by a punctate area; margin of clypeus not as thickened as in *paganensis,* not tuberculate, the disk evenly and closely punctate (in *paganensis* the punctures more separated at base); first segment of flagellum slightly wider than long, the remaining segments about one and one-half times as long as broad except for the last which is twice as long as broad.

Apical margin of first sternite convex in middle; fourth to sixth sternites and genitalia as figured (figs. 22-25).

Allotype: ♀; Peleliu Island, Palaus; July 29, 1945 (H. S. Dybas). [Chicago Natural History Museum.]

Female.—Length 6.1 mm., forewing 4.1 mm. Similar to male in color of pubescence and integument; mesonotum without scattered, moss-like, plumose hairs except along margins.

Mandible with inner margin very deeply, almost semicircularly, incurved basad of inner apical tooth (only slightly and shallowly incurved in *paganensis*), the dorsal carina almost straight, present only on apical half (present on apical two-thirds in *paganensis,* and strongly curved upwards about halfway to base); upper edge of thickened apical margin of clypeus slightly crenulate.

Paratype: ♀; same data as allotype, but July 30, 1945 [U. S. National Museum]. The paratype is slightly smaller (5.6 mm. long) than the allotype, but agrees in details of structure and pubescence.

Megachile (Eumegachile) umbripennis Smith

Megachile umbripennis Smith, 1853. Cat. Hym. Brit. Mus. 1:175 [♀; Nepal; type in British Museum].

Megachile schauinslandi Alfken, 1898. Ent. Nachr. 24:340 [♀; Honolulu; location of type unknown].

Megachile lerma Cameron, 1908. Jour. Bombay Nat. Hist. Soc. 18:654 [♀; Matheram, Bombay Presidency; type in British Museum].

Meade-Waldo, 1914 (Ann. Mag. Nat. Hist. (8) 14:403), synonymized *lerma* with *umbripennis* after an examination of the types, and Cockerell, 1918 (Ann. Mag. Nat. Hist. (9) 2:388), synonymized *schauinslandi* after examining Hawaiian specimens determined as *umbripennis* by Friese.

Timberlake, 1921 (Proc. Hawaii. Ent. Soc. 4:551), suggested that *schauinslandi* might be distinct from *umbripennis* stating that Hawaiian specimens have a short fulvous apical fringe laterally on second tergite, similar white lateral fringes on the third and fourth, and an entire white fringe on the fifth, whereas *umbripennis* is supposed to have only lateral fringes, those of the second and third fulvous, and of the fourth and fifth white. I am not inclined to place much emphasis on these supposed differences. The complete band on the fifth tergite is very readily denuded and is interrupted medianly in some Hawaiian material before me, which specimens also show some variation in the color of the fringe on the third tergite from fulvous to creamy.

The species has been recorded previously from India, China, Siam and Hawaii. Seemingly it is a relatively recent introduction to Micronesia for it was not taken before or during the war.

The closest relative is the Chinese *strupigera* Cockerell, 1922 (Proc. U. S. Nat. Mus. 60, Art. 18:11), which I have seen also from India (identified as *faceta* Bingham by Sladen) and Siam. Cockerell stated that *strupigera* was closely allied to the Javan *thoracica* Smith, but the resemblance is superficial only as a specimen of the latter determined by Cockerell belongs to a different subgenus.

Umbripennis and *strupigera* are referable to the subgenus *Eumegachile* established by Friese for females having a broad short clypeus. So far as I know the species referable to this subgenus are resin-workers rather than leaf-cutters. While these two species do not have such a clypeus in the female, this character probably is not of too much importance as evidenced by the varying proportions of the clypeus in resin-workers of the subgenus *Chelostomoides* Robertson. The males of these two species agree with the known males assigned to *Eumegachile* by Friese in having the clypeal beard developed only along the apical margin and in having a deep depression before the carina of the sixth tergite. Males of *Chelostomoides* have only three exposed sternites (four in *Eumegachile*) and the clypeal beard is not restricted to the apical margin.

Timberlake (*op. cit.*, p. 554) recorded *umbripennis* in Hawaii as constructing its nests of resinous material, frequently in keyholes.

Mariana Islands: 1 ♀; native settlement, Saipan; June 18, 1946 (R. G. Oakley). 1 ♀; Susupe, Saipan; December 31, 1947 (K. L. Maehler; on *Ipomoea* sp.). 2 ♂ ♂; Civil Administration, Saipan; January 11, 1949 (K. L. Maehler). 1 ♀; Saipan; March 4, 1948 (W. H. Lange).

Megachile (Eutricharaea) fullawayi Cockerell

Megachile sp. Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:282 [Guam].
Megachile fullawayi Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:2 [♀, ♂; Guam; type in U. S. National Museum].—Yasumatsu, 1939. Tenthredo 2:336, figs. 13, 17, 22 [♀, ♂; Kusaie, Jaluit Atoll].—Yasumatsu, 1942. Tenthredo 3:335, figs. 1 a-f [♀, ♂; Pagan].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:189.

This species is now widespread in Micronesia. Apparently it became established in Hawaii about 1919 (Timberlake, 1921. Proc. Hawaii. Ent. Soc. 4:556).

Timberlake (*op. cit.*, p. 552) suggested that *fullawayi* was introduced into Hawaii from the Oriental region rather than from Guam because at that time there were not extensive communications with Guam. It seems hard to believe that it is endemic in Micronesia because of the large number of islands on which it has become established. It is close to the Philippine *navicularis* Cockerell, which, however, does not have the anterior margin of the fore basitarsus of the male abruptly narrowed two-thirds the distance to apex, but the segment is equally broad throughout. However, in the series determined as *navicularis* in the U. S. National Museum I found one male *fullawayi* from Occidental Negros (determined as *navicularis* by Sandhouse) which is identical with Micronesian specimens in structural characters and genitalia. The pubescence in the Philippine male is pale fulvous, similar to that in two males from Hawaii and Nukuoro Atoll, rather than the normal (?) white. Perhaps the pubescence is fulvous in newly emerged individuals and fades rapidly to white after exposure to light.

Marshall Islands: 15 ♀ ♀; airfield, Majuro Atoll; August 26, 1946 (H. K. Townes). 1 ♂; Engebi Island, Eniwetok Atoll; May 18, 1946 (R. G. Oakley). 2 ♀ ♀, 1 ♂; Kwajalein Island, Kwajalein Atoll; August 16, 1946 (H. K. Townes). 4 ♂ ♂; same data, but on airfield; August 17, 1946 (H. K. Townes). Yasumatsu records it from Jabor Island, Jaluit Atoll.

Mariana Islands: 2 ♀ ♀, 1 ♂; Guam (D. T. Fullaway; type and cotypes). 1 ♀; Mt. Alutom, Guam; June 18, 1946 (H. K. Townes). 1 ♀; Agrihan; August 1, 1945 (Borror and Holder). Yasumatsu records it also from Pagan.

Caroline Islands: 2 ♂ ♂; Nukuoro Island, Nukuoro Atoll; August 6, 1946 (R. G. Oakley). 1 ♀; Hare Island, Kapingamarangi Atoll; August 3, 1946 (H. K. Townes). 1 ♀; Yaptown, Yap; July 12, 1946 (H. K. Townes). Yasumatsu records it from Kusaie.

Megachile laticeps Smith

Megachile laticeps Smith, 1853. Cat. Hym. Brit. Mus. 1:183 [♂; Philippines; type in British Museum].—Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:63 [♀, ♂; Carolines].—Yasumatsu, 1942. Tenthredo 3:337, fig. 2 [♀, ♂; new syn. and distrib.].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172:188 [♀, ♂; Guam].

Megachile caecina Cameron, 1903. Jour. Str. Br. Roy. Asia. Soc., no. 39, p. 173 [♀; Trusan; type in British Museum].

Megachile borneana Cameron, 1903. Jour. Str. Br. Roy. Asia. Soc., no. 39, p. 174 [♀; Kuching; type in British Museum].

Megachile gadara Cameron, 1903. Jour. Str. Br. Roy. Asia. Soc., no. 39, p. 176 [♂; Kuching; type in British Museum].

Megachile robbii Ashmead, 1904. Proc. U. S. Nat. Mus. 28:128 [♀; Manila; type in U. S. National Museum].

Megachile semperi Friese, 1905. Ztschr. Hym. Dipt. 5:17 [♀; Palaus; location of type unknown].—Yasumatsu, 1935. Mushi 8:95, fig. [♀; Tinian; descr. of nest].—Cockerell, 1939. Occas. Papers B. P. Bishop

Mus. 15:63.—Yasumatsu, 1939. Tenthredo 2:335, figs. 14, 16, 23 [♂; Marianas, Carolines, Palaus].

Megachile varidens Cameron, 1905. Jour. Str. Br. Roy. Asia. Soc., no. 44, p. 166 [♂; Kuching; type in British Museum].

Megachile metallescens Cockerell, 1918. Phil. Jour. Sci. 13:135 [♀; Mt. Maquiling, Luzon; type in U. S. National Museum].

Megachile mcgregori Cockerell, 1918. Phil. Jour. Sci. 13:140 [♂; Mt. Maquiling, Luzon; type in U. S. National Museum].

The Cameron names were synonymized by Meade-Waldo, 1914 (Ann. Mag. Nat. Hist. (8) 14:403), after comparison of the Smith and Cameron types. In 1939 Yasumatsu synonymized *metallescens* under *semperi*. In 1942 he placed *semperi* as a synonym of *laticeps* after Cockerell, 1939, had suggested that *metallescens* was a synonym of *laticeps*. Cockerell, 1931 (Amer. Mus. Novit. 480:3), reported Sandhouse's conclusion that *robbii* and *metallescens* were identical. I am able to confirm this synonymy by examination of the types. Both have the metallic bluish abdominal reflections. The type of *metallescens* differs in that the scopa of the fifth sternite is pale only on the extreme base whereas in the type of *robbii* it is black only laterally on the fifth sternite. As pointed out below, this appears to be within the range of normal variation. Cockerell's synonymy (1942) of *mcgregori* under *laticeps* has been confirmed by comparison of the type and its genitalia with Micronesian material of *laticeps*. The type of *mcgregori* has the peculiar arrangement of hair on the tarsi mentioned in the foregoing key, though in Cockerell's (1918) key it is stated not to have such hair.

There is some variation in the amount of black hairs in the scopa of the fifth sternite. Normally the scopa on this segment is black only laterally; occasionally specimens have the black hairs extending across the apex, or the fifth sternite may be entirely black except for a row or two of pale hairs at the base as in the type of *metallescens*. This variation does not appear to be of any significance for I have found a certain amount of it to exist in series from the Philippines, Palaus and Yap.

This and the following two forms, *palaonica* Cockerell and *diligens hedleyi* Rainbow, are not referable to any of the described subgenera as defined at present. However, it seems premature to erect new subgenera for their reception until the large Oriental and Australian fauna has been studied thoroughly and some knowledge gained as to the relative emphasis to be placed on certain characters. Yasumatsu (1942) suggested that *laticeps* and *palaonica* might belong to the subgenus *Anthemois* Robertson, but as limited at present, the males of that group have a basal tooth on the inferior margin of the mandible and tridentate mandibles, and the females usually have quinquedentate mandibles.

Yasumatsu (1935) describes and figures a nest from Saipan constructed in a dead reed from pieces cut from leaves of *Pithecellobium dulce*.

Mariana Islands: 1 ♀; Mt. Santa Rosa, Guam; May 16, 1945 (G. E. Bohart and J. L. Gressitt) [CAS]. 1 ♀; Tumon Bay, Guam; December 28, 1947 (K. L. Maehler; on *Ipomoea pes-caprae*). 1 ♀; Agaña airport,

Guam; January 30, 1948 (K. L. Maehler). 1 ♀; Agaña springs, Guam; May 23, 1945 (G. E. Bohart and J. L. Gressitt). 1 ♂; Mt. Alutom, Guam; June 18, 1946 (H. K. Townes). 1 ♂; Piti, Guam; August 2, 1936 (O. H. Swezey). 2 ♂ ♂; same data, but September 14, 1936. 1 ♀; same locality, but November 18, 1937 (R. G. Oakley). 3 ♂ ♂; Santa Rita, Guam; January 29, 1949 (K. L. Maehler; on *Ipomoea*). 1 ♀; Barrigada, Guam; June 14, 1936 (O. H. Swezey; on *Crotalaria*). 2 ♂ ♂; Rota, Rota; June 23, 1946 (H. K. Townes). 1 ♂; same data, but June 26, 1946. 1 ♀, 1 ♂; Hagoya Lake, Tinian; June 10, 1946 (H. K. Townes). 1 ♀; hills E. of Garapan, Saipan; January 1, 1945 (H. S. Dybas) [CNHM]. 3 ♀ ♀; native settlement, Saipan; June 18, 1946 (R. G. Oakley). 2 ♂ ♂; Saipan; June 28, 1946 (H. K. Townes). 1 ♀; Saipan; March 4, 1948 (W. H. Lange). 1 ♂; Magicienne Bay, Saipan; February 25, 1949 (K. L. Maehler; on *Ipomoea*). 1 ♀; 1-2 mi. E. of Tanapag, Saipan; November 17, 1944 (H. S. Dybas) [CNHM]. 1 ♂; same data, but April 16, 1945 [CNHM]. 1 ♀; same locality, but December 3, 1944 (S. Edgar) [CNHM]. 1 ♀, 1 ♂; Agrihan; July 29, 1945 (Borror and Holder). 3 ♀ ♀; same data, but August 2-6, 1945 (D. J. Borror). Yasumatsu records it also from Pagan.

Caroline Islands: 1 ♂; Mt. Uiniböt, Tol Island, Truk Atoll; May 24, 1946 (H. K. Townes). 1 ♀; Pis Island, Truk Atoll; June 3, 1946 (H. K. Townes). 1 ♀; Moen Island, Truk Atoll; March 1949 (D. Langford). 2 ♀ ♀; Dublon Island, Truk Atoll; February 10, 1948 (K. L. Maehler; on *Ipomoea*). 5 ♀ ♀; Tomil, Yap; March 5, 1949 (K. L. Maehler; on flowers of *Euphorbia pulcherrima*). 1 ♀; Yaptown, Yap; July 13, 1946 (H. K. Townes). 9 ♀ ♀, 1 ♂; same data, but July 14, 1946. 4 ♀ ♀; Yaptown (labeled Colonia), Yap; March 1-8, 1949 (K. L. Maehler; on *Ipomoea* flowers). 1 ♂; Dugor, Yap; March 1-8, 1949 (K. L. Maehler). 4 ♀ ♀, 1 ♂; same data, but collected on *Ipomoea pes-caprae* flowers. 1 ♀; Gorror, Yap; March 1, 1949 (K. L. Maehler; on *Ipomoea*). 2 ♀ ♀, 2 ♂ ♂; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). 1 ♀; Babelthuap Island, Palaus; July 19, 1946 (H. K. Townes). 1 ♀; Aurungi, W. of Ulimang, Babelthuap Island, Palaus; December 17, 1947 (H. S. Dybas; on nipa palm blossom). 1 ♀; Koror Island, Palaus; March 15-25, 1948 (K. L. Maehler; on *Ipomoea*). Yasumatsu records it also from Kusaie and Ponape.

Megachile palaonica Cockerell

Megachile palaonica Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:62 [♀, ♂; Palaus; type in Bishop Museum].

Megachile subrixator Cockerell, Yasumatsu, 1939. Tenthredo 2:334, figs. 12, 15, 21 [♀, ♂; Palaus; misdetermination of Cockerell species].—Yasumatsu, 1942. Tenthredo 3:340, figs. 3 a-i [♂; Palaus; *palaonica* incorrectly synonymized under *subrixator*].

Probably this is the only true endemic *Megachile* in Micronesia. At least I have found no specimens of it among a large number of *Megachile* from the Oriental and Australian regions. Yasumatsu's identification of this species as the Philippine *subrixator* Cockerell, 1915 (Ann. Mag. Nat. Hist. (8) 15:535), and subsequent synonymizing of *palaonica*

under *subrixator* are incorrect, for an examination of the female type in the U. S. National Museum shows *subrixator* to be a *Megachile* (*Eutricharaea*) close to *fullawayi*. Males associated with female *subrixator* by Cockerell have simple fore tarsi.

Caroline Islands: 1 ♂; Babelthuap Island, Palaus; July 19, 1946 (H. K. Townes). 1 ♀; same data, but July 22, 1946 (R. G. Oakley). 1 ♀, 10 ♂ ♂; Ulimang, Babelthuap Island, Palaus; December 9-21, 1947 (H. S. Dybas). 1 ♀; wooded peak S.W. of Ulimang, Babelthuap Island, Palaus; December 12, 1947 (H. S. Dybas). 1 ♀; Koror Island, Palaus; July 22, 1946 (H. K. Townes). 3 ♀ ♀, 3 ♂ ♂; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes). 1 ♀; same locality, but August 14, 1945 (H. S. Dybas) [CNHM].

Megachile diligens hedleyi Rainbow

Megachile hedleyi Rainbow, 1897. Mem. Austral. Mus. 3:93, pl. 1, fig. 5 [♀; Funafuti; type in Sydney].

Megachile calens Cockerell, 1914. Ann. Mag. Nat. Hist. (8) 14:464 [♀, ♂; Epi, New Hebrides; type in U. S. National Museum].

Megachile vavauensis Cockerell, 1924. Ann. Ent. Soc. Amer. 17:393 [♂; Vavau, Tonga Islands; type in British Museum].

Megachile diligens calens Cockerell, Perkins and Cheesman, 1928. Ins. Samoa, Hym., Pt. 5, Fasc. 1:8 [♀, ♂; Tutuila].

Megachile diligens hedleyi Rainbow, Cheesman, 1936. Trans. Roy. Ent. Soc. London 85:174 [♀, ♂; New Hebrides].

Megachile loiensis Cockerell, 1947. Pan-Pac. Ent. 23:68 [♀; Kwajalein Atoll; type in U. S. National Museum]. **New synonymy.**

Perkins and Cheesman placed *calens* as a subspecies of *diligens*, a treatment in which I concur, and synonymized *vavauensis*. The male type of *calens* does not differ from Micronesian males, and the female cotype of *calens* is identical with the female type and cotype of *loiensis*. Cheesman, 1936 (Trans. Roy. Ent. Soc. London 85:174) synonymized *calens* under the Ellice Islands *hedleyi* Rainbow, an action with which Cockerell did not agree. There are certain differences between Rainbow's description and specimens I identify as *diligens hedleyi*, but Miss Cheesman saw Rainbow's type and informs me that it does not agree with all the characters Rainbow ascribes to it, and that she considers it to be *diligens*.

Diligens hedleyi is uncomfortably close to typical *diligens* Smith from Hawaii, but apparently the female is constantly separated from that of the typical subspecies by having the scopa on the sixth sternite black instead of fulvous, and by the intermixed black hairs on the vertex and scutum which are lacking in typical *diligens*. The separation characters for *diligens* and *loiensis* mentioned by Cockerell do not hold as the color of the tarsal claws, bands on tergites and the mandibles (worn in the type series of *loiensis*) are the same in both subspecies.

Cheesman, 1936, records *diligens hedleyi* as nesting in dry logs on coral beaches in the New Hebrides, and the closely related *diligens buxtoni* Perkins and Cheesman as nesting in ready-made tunnels in

madreporic boulders on coral reefs, both forms constructing the nests from pieces of leaves.

Marshall Islands: 2 ♀ ♀; Loi Island, Kwajalein Atoll; January 14, 1945 and February 8, 1945 (H. S. Wallace; type and cotype of *loiensis*). 1 ♀; Engebi Island, Eniwetok Atoll; May 18, 1946 (R. G. Oakley; on flowers of *Scaevola*). 1 ♂; same data, but (H. K. Townes and R. G. Oakley). 1 ♀, 1 ♂; Japtan Island, Eniwetok Atoll; May 15, 1946 (H. K. Townes). 1 ♀; airfield, Majuro Atoll; August 27, 1946 (H. K. Townes). 1 ♀; Roguron Island, Majuro Atoll; April 18, 1949 (R. P. Owen). 2 ♀ ♀; Bigatyelang Island, Ailinglapalap Atoll; August 25, 1946 (H. K. Townes). 3 ♀ ♀; Bikini Atoll; April 30, 1946 (J. P. E. Morrison). 4 ♀ ♀, 2 ♂ ♂; same data, but July-August 1947 (A. C. Cole).

Caroline Islands: 1 ♀; Murle (*recte* Murilo?) Atoll; April 22, 1948 (K. L. Maehler).

FAMILY APIDAE

This large family of bees is very poorly represented in Micronesia by six species, only two of which are endemic.

KEY TO THE MICRONESIAN APIDAE

1. Length of second submarginal cell along cubital vein equal to or less than length of first cell; hind legs of female with a scopa of dense hairs; males with pale integumental marks on head 2
   Second submarginal cell as long as combined lengths of first and third cells along cubital vein, or closed submarginal absent; hind tibiae of females, except queens of *Trigona*, with a corbiculum, the flattened, expanded outer surface of hind tibia with marginal hairs 4
2. Large bulky forms, bumblebee-like in appearance, the female entirely black and with black hairs, the male largely ferruginous and with fulvous hair; Marianas Guam, Saipan) ..... **Xylocopa brasilianorum varipuncta** Patton, p. 133
   Small slender forms, both sexes with head and thorax dark with metallic greenish or bluish reflections, the males also with pale clypeal markings, the abdomen similarly colored or ferruginous in part, or entirely 3
3. Hypostomal carina high; temples with a moderately broad band of punctures along eye margin, many of which are subcontiguous; scutum with punctures between parapsidal furrows and sides; upper posterior part of mesopleuron rather closely punctate, with only a very small impunctate area; males with second and third tarsal segments with a pale macula; male sixth and seventh sternites as figured (figs. 20, 21), the denticle of sixth bifid; Carolines (Palaus, Yap, Truk) ..... **Ceratina palauensis** Yasumatsu, p. 132
   Hypostomal carina very low; temples with a much narrower band of punctures along eye margin, most of the punctures well-separated; scutum nearly impunctate between sides and parapsidal furrows; upper posterior part of mesopleuron impunctate except along margins; males with tarsal segments immaculate; male sixth and seventh sternites as figured (figs. 18, 19), the denticle of sixth simple; Marianas (Saipan, Rota) ..... **Ceratina mariannensis** Yasumatsu, p. 132
4. Eyes densely hairy; larger forms, 11 mm. or more in length; Marianas (Guam, Saipan), Carolines (Ponape, Palaus) ..... **Apis mellifera** Linnaeus, p. 135
   Eyes bare; smaller forms never over 7 mm. in length (gravid females) and usually much less 5

5. Smaller forms, worker with forewing including tegula not over 3.5 mm. long; scape of male black, the seventh tergite compressed laterally, beaklike and downcurved, the gonoforceps slightly and evenly curved inward toward the tip; Carolines (Palaus).....**Trigona (Tetragona) fusco-balteata** Cameron, p. 133
Larger forms, worker with forewing including tegula 4.5-4.75 mm. in length; scape of male ferruginous, the seventh tergite rather evenly convex, gonoforceps bisinuate; Carolines (Truk).....
.....**Trigona (Tetragona) iridipennis** var. **valdezi** Cockerell, p. 135

Ceratina mariannensis Yasumatsu (Figs. 18, 19)

Ceratina mariannensis Yasumatsu, 1939. Tenthredo 2:346, fig. 2 [♀; Rota Island; type in Kyushu University].—Yasumatsu, 1942. Tenthredo 3:346 [♀; Rota, Saipan; the specimens recorded from Yap and Truk are referable to *palauensis*].

Ceratina sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Rota].

The males of the two endemic *Ceratina* in Micronesia may be readily separated by the characters in the foregoing key. The characters of punctation should also be useful in separating the females.

Dr. Yasumatsu has confirmed my supposition that the specimens recorded by him (1942) as *mariannensis* from Yap and Truk are actually *palauensis* by comparison of his material with a manuscript copy of the foregoing key. The specimens I have seen from Yap are referable to *palauensis*, though the abdomen may or may not be ferruginous in part (entire abdomen ferruginous in Palau material).

Mariana Islands: 6 ♀ ♀; Shinaparu, Rota; June 24, 1946 (H. K. Townes). 1 ♂; Rota, Rota; June 23, 1946 (H. K. Townes).

Ceratina palauensis Yasumatsu (Figs. 20, 21)

Ceratina palauensis Yasumatsu, 1939. Tenthredo 2:344, fig. 1 [♂; Babelthuap and Angaur Islands, Palaus; type in Kyushu University.]

Ceratina mariannensis Yasumatsu, Yasumatsu, 1942. Tenthredo 3:346 [♀, ♂; specimens from Yap and Truk recorded as *mariannensis* referable to *palauensis*].

Ceratina sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Palaus].

As pointed out in the discussion of the preceding species, the specimens from Yap studied by me differ from the Palau specimen in having only the three basal abdominal segments ferruginous, or sometimes all the abdomen dark. I can find no differences in the genitalia, retracted sternites or punctation between Palau and Yap material.

Caroline Islands: 1 ♂; Potangeras Islet, Ulithi Atoll; November 10, 1947 (H. S. Dybas). 1 ♀, 1 ♂; Dugor, Yap; March 1-8, 1949 (K. L. Maehler; on *Terminalia catappa*). 1 ♂; Mt. Matada, Yap; July 12, 1946; (H. K. Townes). 1 ♀, 2 ♂ ♂; Gorror, Yap; March 1, 1949 (K. L. Maehler). 1 ♀; Rumu, Yap; March 1-8, 1949 (K. L. Maehler). 1 ♂; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes). 1 ♂; Ngerehelong, Babelthuap Island, Palaus; December 18, 1947 (H. S. Dybas).

Xylocopa brasilianorum varipuncta Patton

Xylocopa varipuncta Patton, 1879. Canad. Ent. 11:60 [♀; Arizona; location of type unknown].

Xylocopa brasilianorum varipuncta Patton, Ackerman, 1916. Jour. N. Y. Ent. Soc. 24:226.

This large carpenter bee is a very recent introduction to the Marianas, undoubtedly from Hawaii. Nininger, 1916 (Pomona Jour. Ent. Zool. 8:164), records the species in California as preferring to make its tunnels in partially decayed wood.

Mariana Islands: 1 ♀; Kobler Field, Saipan; January 13, 1949 (K. L. Maehler; on *Ipomoea*). 1 ♀; Agricultural Farm, Guam; February 25, 1949 (K. L. Maehler; on *Ipomoea*).

Trigona (Tetragona) fusco-balteata Cameron

? Trigona ruficornis Smith, Horne, 1870. Trans. Zool. Soc. London 7:185.—Smith, 1870. *Op. cit.*, p. 194 [☿; Mainpuri; type in British Museum].

? Melipona smithii Bingham, 1897. Fauna Brit. India, Hym. 1:563 [substitute name for *ruficornis* Smith, preoccupied in *Melipona* by Lamarck].

Trigona fusco-balteata Cameron, 1908. Entomologist 41:194 [☿; Sarawak; type in British Museum].—Schwarz, 1939 b. Mushi 12:151 [Palaus].

Trigona atomella Cockerell, 1919. Ann. Mag. Nat. Hist. (9) 3:243 [☿; Penang; type in U. S. National Museum].—Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:64 [Palaus].

Trigona pygmaea Friese, 1933. Naturh. Maandblad 22:147 [☿; Sumatra; location of type unknown].

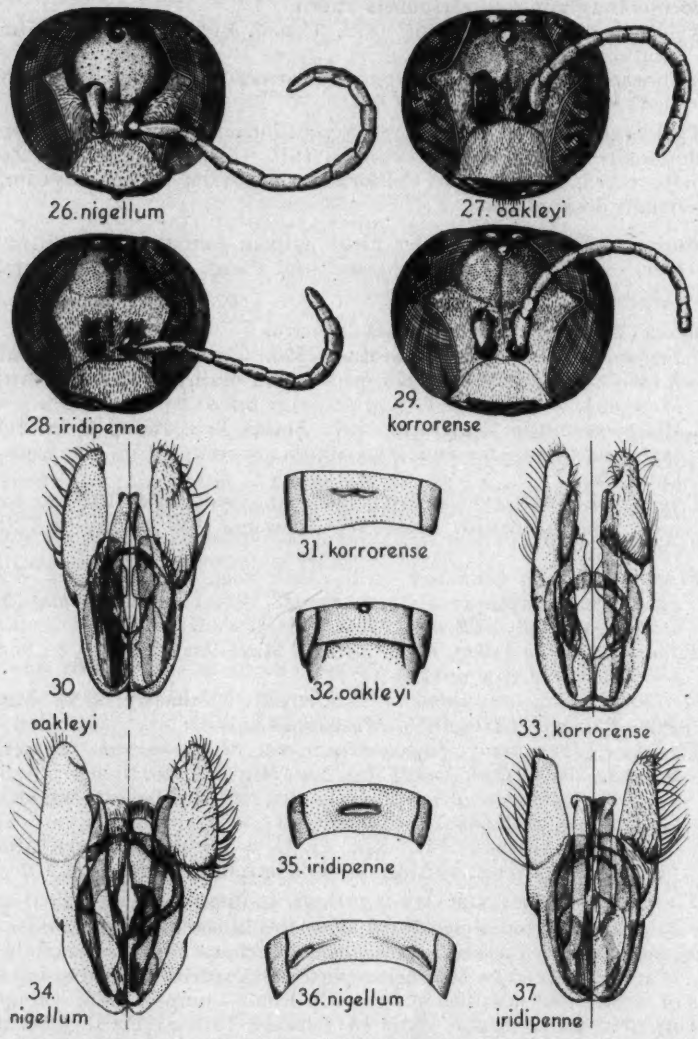
Melipona (*Trigona*) *atomella* (Cockerell), Yasumatsu, 1935. Mushi 8:94 [Palaus].—Esaki, 1936. Mushi 9:44-5.

Trigona (*Tetragona*) *fusco-balteata* var. *fusco-balteata* Cameron, Schwarz, 1939 a. Bul. Amer. Mus. Nat. Hist. 76:107-110, figs. 5 A, 6 A, 7 A, 8 A [synonymy, description, habits; recorded from French Indo-China south to Celebes, Philippines].

Trigona spp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Palaus; visiting resinous secretions of *Wedelia biflora*].

This small stingless honeybee is perhaps an intentional introduction to the Palaus. It is readily separated from the introduced *iridipennis* var. *valdezi* of Truk by the smaller size and other characters mentioned in the key. Pagden, quoted by Schwarz, reported this species as nesting in crevices of timber and jalousies in houses in Kuala Lumpur. The synonymy as suggested above is that given by Schwarz, 1939 a. He suggests that *fusco-balteata* represents a callow form of *atomella*, and notes that Palau specimens are somewhat larger than typical *fusco-balteata*, and approach small specimens of typical *iridipennis* in wing length.

Townes' mention of two species of *Trigona* occurring in the Palaus is undoubtedly due to this species having been recorded from there as *atomella* by Cockerell and Yasumatsu and as *fusco-balteata* by Schwarz.



PISON MALES. Fig. 26, P. nigellum, head; **fig. 27, P. oakleyi,** head; **fig. 28, P. iridipenne,** head; **fig. 29, P. korrorense,** head; **fig. 30, P. oakleyi,** genitalia; **fig. 31, P. korrorense,** 3rd sternite; **fig. 32, P. oakleyi,** 3rd sternite; **fig. 33, P. korrorense,** genitalia; **fig. 34, P. nigellum,** genitalia; **fig. 35, P. iridipenne,** 3rd sternite; **fig. 36, P. nigellum,** 3rd sternite; **fig. 37, P. iridipenne,** genitalia.

Caroline Islands: 8 ☿ ☿; Peleliu Island, Palaus; July 23, 1946 (H. K. Townes). 33 ☿ ☿; same data, but July 31-August 1, 1945 (E. Hagen) [CAS]. 4 ☿ ☿, same data, but (H. S. Dybas) [CNHM]. 14 ☿ ☿; Arakabesan Island, Palaus; July 18, 1946 (H. K. Townes). 1 ☿; Koror Island, Palaus; July 20, 1946 (R. G. Oakley). 4 ☿ ☿; same data, but July 23, 1946. 1 ☿; same data, but northeast corner of island, July 22, 1946 (H. K. Townes). 259 ☿ ☿, 1 ♂; same data, but March 8, 1949 (K. L. Maehler; entrance of nest in crack in wall). 1 ☿; same data, but February 8-15, 1949 (M. M. Ross). 4 ☿ ☿, 46 ♂ ♂; same locality, but November 20, 1947 (H. S. Dybas; bees in swarm about building with nests in cracks in walls). Numerous ☿ ☿ and ♂ ♂; same locality, but December 2, 1947 (H. S. Dybas; bees dancing in swarm about building—tubular openings in cracks in wood walls). 1 ♀; same locality, but February 15, 1948 (H. S. Dybas). 1 ☿; Gapik, Babelthuap Island, Palaus; July 19, 1946 (H. K. Townes). 24 ☿ ☿; Ngerehelong, Babelthuap Island, Palaus; December 18, 1947 (H. S. Dybas). 3 ☿ ☿; Airai, Babelthuap Island, Palaus; January 20, 1948 (H. S. Dybas).

Trigona (Tetragona) iridipennis var. **valdezi** Cockerell

Trigona valdezi Cockerell, 1918. Ann. Mag. Nat. Hist. (9) 2:387 [☿; Singapore; type in U. S. National Museum].—Cockerell, 1939. Occas. Papers B. P. Bishop Mus. 15:64 [♀; Truk].

Trigona (*Tetragona*) *iridipennis* var. *valdezi* Cockerell, Schwarz, 1939 a. Bul. Amer. Mus. Nat. Hist. 76:116 [synonymy, descriptive notes; recorded from French Indo-China south to Borneo, Philippines].—Schwarz, 1939 b. Mushi 12:152 [Truk].

Trigona sp. Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Truk].

This also is probably an introduced species on Truk. Schwarz, 1939 a, separates the variety *valdezi* from typical *iridipennis* by the slightly greater wing length of the worker, 4¾ mm. in the former and 4¼ mm. in the latter. No data have been presented on the nesting habits of the variety *valdezi*, though Schwarz, 1939 a, summarizes the information on typical *iridipennis*.

Caroline Islands: 1 ☿; Tol Island, Truk Atoll; May 25, 1946 (H. K. Townes). 1 ☿; same data, but January 7-27, 1949 (D. Langford). 6 ☿ ☿; Moen Island, Truk Atoll; February 8, 1948 (K. L. Maehler; on wild legume). 1 ☿; Dublon Island, Truk Atoll; February 9, 1948 (K. L. Maehler).

Apis mellifera Linnaeus

Apis mellifera Linnaeus, 1758. Syst. Nat., 10th Edit., p. 576.—Fullaway, 1913. Proc. Hawaii. Ent. Soc. 2:282 [notes that it was introduced on Guam from Hawaii in 1907].—Esaki, 1936. Mushi 9:44 [notes that it was introduced on Koror Island, Palaus in 1912].—Cockerell, 1942. B. P. Bishop Mus. Bul. 172: 188 [Guam].—Townes, 1947. Rpt. 14, U. S. Comm. Co. Surv. Micronesia, p. 51 [Ponape, Palaus, southern Marianas, common only on the latter group].

Cockerell, quoting Swezey, states that the honeybee on Guam is not used for commercial production. Any convenient box is used for a hive, and wild colonies occur in trees and in limestone cliffs.

Mariana Islands: 1 ☿ ; Asumiatok, Saipan; August 27, 1944 (D. G. Hall). 1 ☿ ; 1-2 mile E. of Tanapag, Saipan; November 25, 1944 (H. S. Dybas) [CNHM]. 1 ☿ ; Point Ritidian, Guam; June 1945 (J. L. Gressitt). 4 ☿ ☿ ; Point Oca, Guam; May 1945 (J. L. Gressitt and G. E. Bohart). 3 ☿ ☿ ; Pago Bay, Guam; June 2, 1945 (H. S. Dybas) [CNHM]. 1 ☿ ; Mt. Santa Rosa, Guam; May 16, 1945 (G. E. Bohart and J. L. Gressitt) [CAS]. 1 ☿ ; Agaña, Guam; May 7, 1945 (G. E. Bohart and J. L. Gressitt) [CAS].

Caroline Islands: 4 ☿ ☿ ; Colonia, Ponape; August 9, 1946 (H. K. Townes). 1 ☿ ; same locality, but March 14, 1948 (H. S. Dybas). 1 ☿ ; Auak, Ponape; August 12, 1946 (H. K. Townes). 5 ☿ ☿ ; Koror Island, Palaus; July 23, 1946 (H. K. Townes). 1 ☿ ; same locality, but November 24, 1947 (H. S. Dybas).

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APPENDIX I

Some additional wasps have been examined since the publication of Part I, but I include here only the records from new islands and certain other notes. Several plates of illustrations for some of the species treated in Part I are also included here.

FAMILY SCOLIIDAE

Campsomeris (Campsomeriella) manokwariensis (Cameron)

? Scolia agilis Smith, 1858. Jour. Proc. Linn. Soc. Zool. 3:10 [♂; Celebes; type in Oxford Univ.].

Scolia annulata (Fabricius), Smith, 1861. Jour. Proc. Linn. Soc. Zool. 6:53 [♀; Celebes; misdetermined].

Dielis manokwariensis Cameron, 1906. Res. Exped. Neerl. Nov. Guin. 5:52 [♀; Manokwari, New Guinea; type in Zool. Mus., Amsterdam].

Dielis humboldti Cameron, 1906. Res. Exped. Neerl. Nov. Guin. 5:53 [♀; Humboldt Bay, New Guinea; type in Zool. Mus., Amsterdam].

Campsomeris (*Campsomeris*) *manokwariensis* (Cameron), Betrem, 1928. Treubia, Suppl. vol. 9:123, fig. 57 (labeled *humboldtii*) [♀, ♂; Celebes, New Guinea, Bismarck Arch.; redescription, synonymy as given above].

Campsomeris annulata (Fabricius), Townes, 1946 [1947]. Rpt. 14, U. S. Comm. Co. Econ. Surv. Micronesia, p. 51 [misdetermined, in part].

Campsomeris (*Campsomeris*) *annulata* (Fabricius), Krombein, 1949. Proc. Hawaii. Ent. Soc. 13:374 [misdetermined, in part].

The present species is very similar in general appearance to *annulata* and has been confused with it more than once. The females of *manokwariensis* are distinguished by having the wings entirely dark fuscous rather than only the apical third as in *annulata*, and the vertex, postscutellum and median area of the dorsum of the propodeum impunctate or practically so, as opposed to the moderately densely punctate condition of these areas in *annulata*. The males of the two species are much more difficult to separate with certainty on external characters, but in doubtful cases the genitalic characters may be relied on, the genitalia of *manokwariensis* having the paramere equal in width throughout (greatly widened at the middle in *annulata*), and the squama with very dense, long hair (with sparse, short hair in *annulata*). Typically, *annulata* males have apical yellow bands on the first five abdominal tergites, paired lateral spots on the scutellum, a median band on the postscutellum, and lateral spots on the clypeus, while *manokwariensis* males have apical bands on only the first four tergites and lateral spots on the clypeus, but lack the yellow markings on the scutellum and postscutellum. However, *annulata* males occasionally show some reduction in markings, the band on the fifth tergite may be lacking and the spots on scutellum and postscutellum may be reduced or lacking; in these cases the clypeal spots are also reduced or lacking, and this will aid in separating those *annulata* with only four abdominal bands from the similarly marked *manokwariensis*.

There is some doubt as to the correctness of the synonymy given above, as Betrem notes that the type of *manokwariensis* has yellowish abdominal fringes (Cameron says bright fulvous). Betrem suggests that this coloration may have been caused by immersion in alcohol, and states that if it is found to be natural coloration that the white-fringed form should be known as var. *humboldti*. In a long series of *manokwariensis* from New

Guinea before me, the abdominal fringes of the females vary from white to creamy.

I have seen no published records relative to the introduction of *manokwariensis* and *annulata* into the Marianas. I feel certain that neither is an endemic species there, for they are absent from the rest of Micronesia and were not taken on any of the prewar surveys, though they were abundant as early as 1945. It is most likely that they were introduced, accidentally or intentionally during the early part of the war, during the Japanese occupation.

Mariana Islands: 1 ♀; 3 ♂ ♂; Mt. Alutom, Guam; June 6, 1946 (H. K. Townes). 4 ♂ ♂; Oscilita, Rota; June 27, 1946 (R. G. Oakley). 1 ♀; central section, Tinian; October 10-15, 1945 (H. S. Dybas) [CNHM].

Scolia (Triscolia) procer Illiger

Scolia procer Illiger, 1802. Mag. f. Insektenk. 1:196 [♀, ♂; Sumatra; type in Zool. Mus., Berlin].

Scolia (Triscolia) procer Illiger, Saussure and Sichel, 1864. Cat. Spec. Scolia, p. 43.—Betrem, 1928. Treubia, Suppl. vol. 9:240 [♀, ♂; redescription; Borneo to Tenasserim].

C. P. Clausen informs me that according to a report by K. L. Maehler this species was introduced into the Palaus with *Scolia (Triscolia) patricialis plebeja* (Gribodo) for control of *Oryctes rhinoceros* (Linnaeus).

It is a large species, rather similar to *patricialis plebeja* in general appearance, but lacks the dense black hair on the pronotum before the tegula, and the female has a tubercle in that area which is lacking in *patricialis plebeja.*

FAMILY POMPILIDAE

Episyron maehleri Krombein

1 ♀; limestone ridge S. of inlet, Koror Island, Palaus; January 18, 1948 (H. S. Dybas). The second known female; agrees in all essentials with the type.

FAMILY SPHECIDAE

Chalybion bengalense (Dahlbom)

1 ♀; Com. Mar. Hill, Guam; March 28, 1949 (K. L. Maehler).

Sceliphron laetum (Smith).

1 ♀, 2 ♂ ♂; Yaptown (labeled Colonia), Yap; March 1-8, 1949 (K. L. Maehler). 1 ♂; Dugor, Yap; March 1-8, 1949 (K. L. Maehler).

Dasyproctus immaculatus Krombein

2 ♀ ♀; Peleliu Island, Palaus; August 10, 1945 (E. Hagen) [CAS]. 1 ♀; same locality, but January 24, 1948 (H. S. Dybas). 1 ♀; Angaur Island, Palaus; February 4, 1948 (H. S. Dybas). Recorded previously only from Koror Island, Palaus.

Pison punctifrons Shuckard

1 ♀; Colonia, Ponape; February 26, 1948 (H. S. Dybas). 1 ♂; same locality, but January 7-31, 1949 (M. M. Ross).

Pison nigellum Krombein (figs. 26, 34, 36)

13 ♀ ♀; Mt. Tamatamansakir, Ponape, 500-1000 ft. alt.; February 29, 1948 (H. S. Dybas; about holes in clay bank along trail in secondary forest—gallery system about six inches deep with burrows leading further in).

So far as I know this is the first record of a species of this genus nesting in this type of situation, other species having been recorded as constructing clay cells above ground in sheltered situations. In reply to my inquiry as to whether the wasps were actually nesting in the soil or whether they might have been preying on ground-burrowing spiders, Dr. Dybas wrote, "I have a clear recollection as to the circumstances under which these wasps were captured. I noted the wasps flying in small numbers about a series of openings in a cut along the side of the trail. The openings were in a group about a foot in diameter and led into a loose honey-combed pocket which extended about six inches into the side of the trail. I scraped some of this loose earth away and noted several burrows extending further into the earth. Unfortunately, I did not investigate further and found no provisioned cells. However, I do not think these were spider burrows, being totally unlike any spider burrows that I know." Since this species, like other *Pison*, lacks a tarsal comb, it is possible that it does no excavating, but utilizes abandoned burrows of other insects.

Pison argentatum Shuckard

1 ♀; Yaptown (labeled Colonia), Yap; March 1-8, 1949 (K. L. Maehler).

Pison hospes Smith

4 ♂ ♂; Bikini Atoll; July-August 1947 (A. C. Cole).

Pison iridipenne Smith (figs. 28, 35, 37)

1 ♂; Civil Administration, Saipan; January 10, 1949 (K. L. Maehler). 1 ♀; Tanapag, Saipan; January 14, 1949 (K. L. Maehler).

Pison korrorense Yasumatsu (figs. 29, 31, 33)

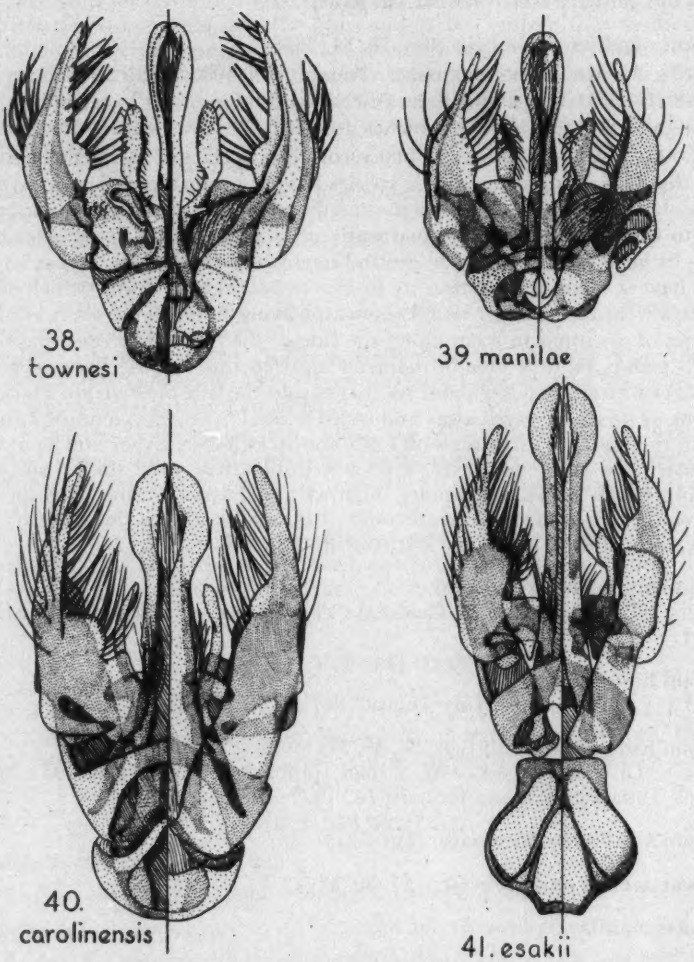
Pison oakleyi Krombein (figs. 27, 30, 32)

Motes manilae (Ashmead) (fig. 39)

Motes townesi Krombein (fig. 38)

1 ♀; Peleliu Island, Palaus; July 30, 1945 (H. S. Dybas) [CNHM]. 3 ♂ ♂; same locality, but January 26, 1948. 1 ♂; Koror Island, Palaus; November 21, 1947 (H. S. Dybas). 1 ♀; same data, but December 2, 1947. 4 ♂ ♂; Angaur Island, Palaus; February 3, 1948 (H. S. Dybas).

The females are very similar to the type, and the males vary in length from 6.1 to 8.2 mm.



MOTES AND LIRIS MALE GENITALIA. Fig. 38, M. townesi; fig. 39, M. manilae; fig. 40, L. carolinensis; fig. 41, L. esakii (cardo displaced).

Dicranorhina luzonensis Rohwer

Dicranorhina luzonensis Rohwer, 1919. Bul. 14, Ent. Ser., Hawaii. Sugar Planters' Assoc., pp. 6-7 [♀, ♂; Los Baños, Luzon; type in U. S. National Museum].

Dicranorhina sp. Krombein, 1949. Proc. Hawaii. Ent. Soc. 13:370, 382, 394.

In Part I I mentioned the probability that the specimens seen in the Palaus by Dr. Williams were *luzonensis*. Two males taken on Koror Island, Palaus, March 1, 1949 (K. L. Maehler) suggest this supposition was probably correct. Other specimens examined: 4 ♂ ♂; Peleliu Island, Palaus; January 30, 1948 (H. S. Dybas). 1 ♂; Angaur Island, Palaus; February 4, 1948 (H. S. Dybas).

Liris esakii Yasumatsu (Fig. 41)

Liris esakii Yasumatsu, 1941. Mushi 14:46, pl. 1, figs. 1-3 [♀, ♂; Yap specimens only; Truk ♀ paratype is referable to *carolinensis* Yasumatsu; type in Kyushu University].—Krombein, 1949. Proc. Hawaii. Ent. Soc. 13:397 [Yap ♀ only; Truk specimens referable to *carolinensis* Yasumatsu].

Liris carolinensis Yasumatsu, new status (Fig. 40)

Liris mindanaoensis carolinensis Yasumatsu, 1941. Mushi 14:46, pl. 1, fig. 5 [♂; Truk; type in Kyushu University].—Krombein, 1949. Proc. Hawaii. Ent. Soc. 13:399.

Liris esakii Yasumatsu, 1941. Mushi 14:47 [♀ paratype from Truk only].—Krombein, 1949. Proc. Hawaii. Ent. Soc. 13:383 (in key), 397-8 [Truk specimens only].

The confusion as to the identification of *esakii* and *carolinensis* has been caused by lack of material, and the fact that females of the two forms are quite similar. When making the original description of *esakii* Yasumatsu had a series of both sexes from Yap, but only one female from Truk, and assumed that the latter was conspecific with the Yap specimens. When I prepared Part I of this series, I had a short series of both sexes from Truk which I assumed were *esakii*, though I did note certain differences in the apical margin of the clypeus of the males as compared with Yasumatsu's figure, but ascribed these differences to variability in the one species. A single female paratype of *esakii* from Yap was received from Dr. Yasumatsu in late December of 1948 after Part I had gone to the printer, but at that time did not seem different enough from my Truk females to arouse any suspicions that two species were involved. It was not until K. L. Maehler sent in a series of one female and two males collected at Yaptown (labeled Colonia), Yap, March 1-8, 1949, that I realized that the Yap form was specifically distinct from the one occurring on Truk.

The male type of *carolinensis* apparently is an abnormal specimen as the measurements given by Yasumatsu indicate a much smaller specimen than the two before me which average 8.5 mm. in length.

Dr. Yasumatsu has confirmed the synonymy of the two species of *Liris* as given above by comparison of specimens sent him and the following

key with the type series of the two species in the collection of Kyushu University.

Couplets 16 and 17 of my key (Proc. Hawaii. Ent. Soc. 13:383, Part I) to the Micronesian Sphecidae may be amended as follows to provide for the additional species.

16. Dorsum of propodeum with a strong median carina almost to apex, median groove not well marked, the carinae elsewhere on disk stronger and curving outwardly; mesoscutal punctation sparser posteriorly, most of punctures there separated by more than the width of a puncture; wings strongly infumated with brown and with violaceous reflections; Carolines (Truk)..... **Liris carolinensis** Yasumatsu

Dorsum of propodeum with median carina lacking, or present at most on basal half, the median groove well developed, carinae elsewhere on disk weaker, oblique or transverse, frequently present only toward sides; mesoscutal punctation denser, the punctures separated by not more than the width of a puncture posteriorly, and frequently much less; wings less strongly infumated or hyaline except for tips..... 17

17. Pygidial pile of female golden; posterior surface of propodeum shining, smooth; Carolines (Ponape)..... **Liris samoensis** Williams

Pygidial pile of female dark brown; posterior surface of propodeum dull, scabrous 17a

17a. Wings uniformly infumated, though not so dark as in *carolinensis*, and with violaceous reflections; head and thorax shaggier in appearance than in *williamsi* owing to the somewhat longer erect hair; Carolines (Yap)..... **Liris esakii** Yasumatsu

Wings hyaline with iridescent reflections, slightly infumated at apex; male unknown; Carolines (Palaus)..... **Liris williamsi** Krombein

The Biology of the Mariana Coconut Beetle, Brontispa mariana Spaeth, on Saipan, and the Introduction of Parasites from Malaya and Java for its Control[1]

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UNIVERSITY OF CALIFORNIA, DAVIS

(Presented by Mr. Van Zwaluwenburg at the meeting of April 11, 1949)

The Mariana coconut beetle, *Brontispa mariana* Spaeth, is a serious pest of the coconut palm, *Cocos nucifera*, on certain of the islands of Micronesia, particularly Saipan and Rota in the Mariana group. As a result of the depredations of this beetle a former copra and coconut oil industry of sizeable proportions has been almost completely eliminated. Esaki (1940) states that it was first discovered on Saipan in 1931 and during 1935 and 1936 caused such severe damage that in 1936 about 70 per cent of the plantations were burned over. In view of its wide distribution in the Carolines on coconuts there is considerable evidence to indicate that it was brought to Saipan on coconut seedlings for planting stock. Swezey (1940) mentions the fact that in 1936 a Japanese boat reversed the order of its route so as not to go from Saipan to Guam and increase the possibility of introducing it to Guam.

The reports of Townes and Oakley (1946) based on their survey for the United States Commercial Company pointed out the severe damage caused by the beetle on Saipan and Rota and suggested either eradication of the coconut trees or the introduction of natural enemies. The few remaining larger coconut trees on Tinian and a limited number on Saipan were cut and destroyed prior to the initiation of this investigation. The recommendations for this research were contained in the reply of Knowles A. Ryerson, chairman of the Pacific Science Board, to Admiral Chester W. Nimitz, dated 7 July 1947. During the period 19 November 1947 to 6 February 1948 a search was made for parasites associated with externally-feeding hispid beetles in the Philippines, Malaya, and Java, and, as a result, two parasites were introduced to Saipan and Rota.

SYSTEMATIC POSITION.—The Mariana coconut beetle, *Brontispa mariana* Spaeth, belongs to the subfamily Hispinae of the beetle family Chrysomelidae. It was named by Spaeth (1937) from specimens collected on coconut palm on Saipan in July 1936. Spaeth placed it close to *B. limbatus* Waterhouse in general coloration and size. Chujo (1937) described it as a new genus and species, *Planispa castaneipennis* Chujo,

[1] These investigations undertaken as a project of the Pacific Science Board under the direction of the Insect Control Committee for Micronesia, at the request of the United States Navy. Collecting was done on a survey made under the auspices of the Insect Control Committee for Micronesia of the Pacific Science Board, National Research Council, with financial assistance from the Office of Naval Research.

[2] On loan to the Pacific Science Board of the National Research Council as Field Associate in Entomology, 1 October 1947 to 1 May 1948.

from specimens collected on Saipan. The genus *Brontispa* was erected by Sharp (1903).[3] Weise (1911) lists the related genera as *Leucispa* Chapuis, South Australia; *Octodonta* Chapuis, Malaya; *Plesispa* Chapuis, Malaya and Java; *Oxycephala* Guerin, New Guinea, Aru Islands, New South Wales, and Solomon Islands; and *Xiphispa* Chapuis, New Guinea and Madagascar.

DISTRIBUTION OF THE GENUS BRONTISPA.—The center of distribution of the genus *Brontispa* is in the Austro-Malayan region. Most of the species occur in the Pacific Ocean between 20° north and south of the equator, and 100° to 180° east longitude. The known distribution summarized chiefly from Maulik (1938) is as follows: Philippine Islands, *depressa* Baly, *angulosa* Uhmann, *banguiensis* Uhmann, and *surigaoana* Uhmann; Marianas, *mariana* Spaeth; Carolines, *mariana* Spaeth, *chalybeipennis* Zacher, and *namorikia* Maulik; New Guinea, *longissima longipennis* Gestro, and *linearis* Spaeth; Solomons, *longissima froggatti* Sharp; Java, *longissima javana* Weise, *longissima celebensis* Gestro, and *affinis* Uhmann; Celebes, *longissima celebensis* Gestro; Aru Island, *longissima longissima* Gestro; Lord Howe Island, *longissima castanea* Lea; Witu Islands, *longissima simmondsi* Maulik; Ceram, *longissima reicherti* Uhmann; Mauritius, *gleadowi* Weise; and Rodriguez Island, *limbatus* Waterhouse.

DISTRIBUTION OF BRONTISPA MARIANA SPAETH.—The Mariana coconut beetle has a wide distribution in the Mariana and Caroline Islands of Micronesia. The known distribution is as follows:[4] Marianas: Rota (Esaki, 1940; Townes and Oakley, 1946); Saipan (Esaki, 1940; Swezey, 1940; Townes and Oakley, 1946); Carolines: Truk (Moen, Tol, Fefan, Udet Islets); Yap; Woleai (Utagal Islet); Nukuoro (Shenukdei Islet); Ulithi (Fassarai and Mogmog Islets); Hall Islands (Nomwin); and Ponape? (Oakley, 1946).

The present writer was able to verify the occurrence of *Brontispa mariana* on Saipan and Rota. A survey of Tinian indicated that the few remaining seedling coconut trees were not infested. Specimens supposedly this species from Anatahan were determined by L. L. Buchanan as a *Sessinia* sp. in the family Oedemeridae. *Brontispa mariana* is not the sole representative of this genus in the Carolines as *B. chalybeipennis* Zacher, according to Esaki (1940), is reported from Ponape, Kusaie, and the Marshalls, a *Brontispa* species from the Palau Islands is reported by Oakley (1946), and *Brontispa namorikia* recently described by Maulik is reported from Kusaie.[5]

DESCRIPTION OF THE STAGES.—EGG: The eggs of *Brontispa mariana* are capsular, elongate-spheroid, flattened, dark brown in color, and are laid singly or end to end in groups up to six in number. In size the

[3] Sharp, Proc. Linn. Soc. N. S. Wales 1903(1904), p. 924.

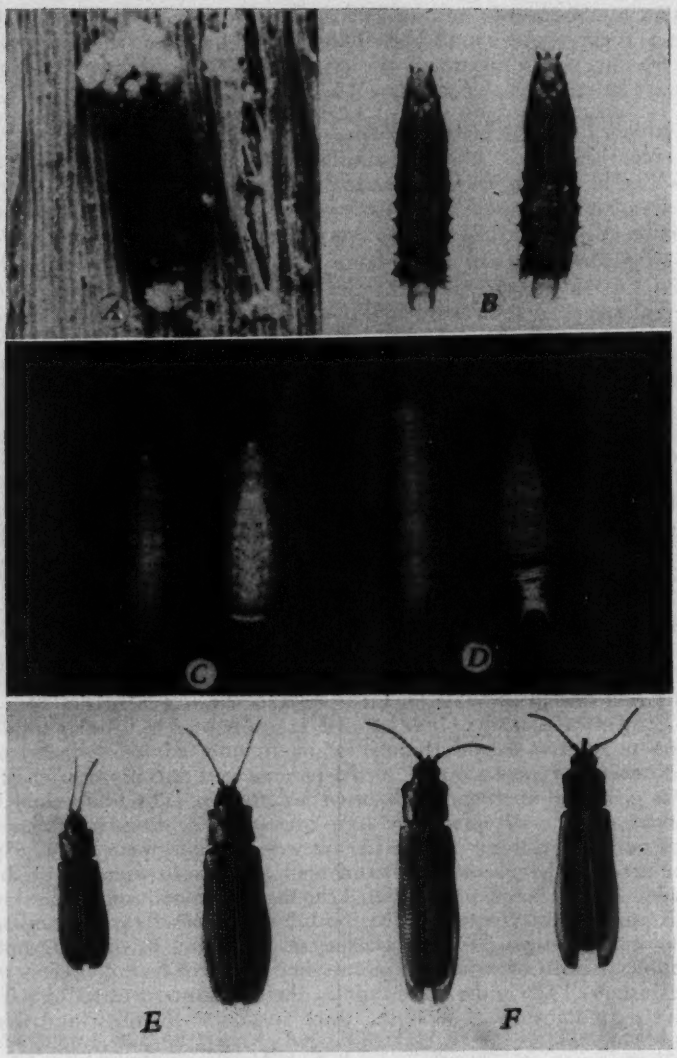
[4] Records without author references supplied by C. F. W. Muesebeck, from the United States National Museum collection.

[5] Record according to E. C. Zimmerman of the Hawaiian Sugar Planters' Experiment Station. See Maulik, S. 1946. A new species of *Brontispa* from the Pacific. Ann. Mag. Nat. Hist., 13(11):498-502.

width varies from 0.70 mm. to 0.93 mm., with an average width of 0.80 mm., and the length varies from 1.48 mm. to 1.80 mm. with an average of 1.60 mm. The surface of the egg has shallow, hexagonal reticulations. The egg is shown in plate 1A.

LARVA: The larvae molt three times and have four larval instars. With the exception of size, and minor differences, the larval instars are similar. The first instar larva lacks the dorsal row of teeth on the posterior processes, and the lateral abdominal processes are broader. In the second instar teeth occur on the posterior processes, and in the third instar the lateral abdominal processes become less lobe-like and resemble those present in the fourth instar. The approximate length of the larvae at different stages in their growth is as follows: at hatching from the egg, 2-3 mm.; first molt, 4 mm.; second molt, 5-5.5 mm.; third molt, 7-8 mm.; and the mature larva, 9-11 mm. A description of the fourth larval instar is as follows (see plate 1D): the larva is flattened dorso-ventrally, and has a characteristic, chitinized pair of hooks, and a pair of fleshy protuberances from each of the abdominal segments—one from each side, located laterally. The larva is 7 to 8 mm. long at the time of molting, attaining a length of 9 to 11 mm., and is a yellowish white in color. The head is broad, concolorous with the body; the antennae are short, three-segmented, with two terminal palp-like projections; the eyes are made up of a ring of five ocelli; and the labrum is broad and entire. The mouth parts are located ventrally; the maxillary palpi are short and three-segmented, and the labial palpi are short, and two-segmented; and the mandibles are well developed, stout basally, with two terminal teeth, and hollowed terminally to serve as chisels for use in scooping out portions of leaf surface. Three pairs of thoracic legs are present, with a single, well developed claw on each leg, and flap-like structure opposite each claw. One pair of well developed, laterally placed, tubular spiracles is present on the second thoracic segment, one pair of spiracles each on abdominal segments 1 to 7, and a pair located dorsally near the base of the posterior hooks on abdominal segment 8. The abdominal segments have a laterally placed, fleshy protuberance from each of segments 1 to 8, and a posterior forceps-like process from segment 8. The posterior processes have a dorsal row of teeth. A measurement of the head capsules of 1,090 larvae substantiated the fact that four instars are present. Upon plotting the frequency distribution of the head capsule widths it was possible to segregate four classes corresponding to the four instars as follows: width of head capsule at time of hatching up to first molt (first instar), 19-26 units (one unit in these measurements equals 0.025 mm.); second instar, 27-36 units; third instar, 37-46 units; and fourth instar, 47-63 units.

PUPA: The pupa is elongate, flattened, widening slightly posteriorly, and has a characteristic posteriorly located forceps-like structure similar to that of the larva. The cast skin of the fourth instar larva usually remains attached at the posterior end of the pupa, but is easily removed to show the pupal processes. The pupa is yellowish white in color with



A. Egg of *Brontispa mariana* Spaeth, × 20.
B. Pupae of *Plesispa reichei* Chap., parasitized by *Tetrastichus brontispae* (Ferrière), × 3.
C. Mature larva and pupa of *Plesispa nipae* Maulik, × 3.
D. Mature larva and pupa of *Brontispa mariana*, × 3.
E. Male, left, female, right, of *Plesispa nipae*, × about 3.
F. Female, left, male, right, *Brontispa mariana*, × about 3.

brownish posterior hooks, and the male pupa is 8 to 9 mm. long, and the female pupa 9 to 10.5 mm. long. The average width of the pupa of both sexes is 2 mm. The head has two characteristic, downwardly projecting, hook-like structures arising anterior to the eyes, and a conspicuous frontal process which in the male is long, and terminates bluntly in front and in the female is short and sub-acute apically. The antennae are free, and long. Rudimentary mouthparts are present. The wings and legs are partly free and distinctly visible. Dorsally the abdomen has segments 2 to 7 with sparsely distributed, dark spicules, and ventrally segments 4 to 7 have a medial row of six spicules; and laterally on each segment is a tubercle with a few terminal hairs. The posterior forceps are smooth, unlike those of the fourth instar larva. The pupa is shown in plate 1D.

ADULT: The adult beetle is uniform dark brown in color, glossy, and greatly flattened dorso-ventrally (see plate 1F). The females range from 8.5 to 10.5 mm. long, with an average of 8.6 mm. (exclusive of antennae), and are approximately 2 mm. wide, and the males range from 6.75 to 9 mm. long, averaging 7.5 mm. long, and are 2 mm. wide. The antennae are sub-filiform, stout, 11-segmented, and 1.8 to 2.3 mm. long; the scape is over twice as long as segment 2; and segments 7 to 11 are closely joined, and almost club-like. The head is flattened with the mouthparts arising ventrally, and the front is produced into characteristic interantennal processes which in the males are almost half as long as the head and terminate abruptly, and in the females are one-fourth the length of the head, and terminate less abruptly; the head is deeply grooved lengthwise through the center and the grooves extend into the interantennal processes; the eyes are large, and black in color; and the head is sparsely punctate above. The thorax is sub-rectangular with the apical angles broadly expanded, particularly in the females, and with a slight projection; the posterior angles have a short spine; and the dorsal surface is sparsely and deeply punctate at the edges with considerable impunctate area medially. The elytra are elongate, and slightly expanded apically, with eight rows of sub-quadrangular depressions running longitudinally; the lateral margins are upturned; and the interstices are not raised into costae. The legs are short with trochanters present, and the femora are enlarged; the tibiae are set distally with several short, heavy-set spines; and the tarsal segments are greatly flattened, have two terminal claws, and are covered ventrally with a thick pubescence.

LIFE HISTORY.—The Mariana coconut beetle belongs to a group of leaf-feeding hispid beetles which feed externally on the buds and new growth of palms and other plants. The beetle under discussion feeds in the buds of the coconut palm, *Cocos nucifera*, where as both larvae and adults it feeds inter- and intra-pinnately, scraping off the leaf surfaces and causing characteristic, darkened blemishes which persist during the interval of time the leaf remains on the tree. The damage is shown in figure 1.

In the laboratory on Saipan it was found that the life history could be studied satisfactorily by confining all stages in small Stender dishes.

Larvae were fed small pieces of coconut leaves, changing the food daily, and a small piece of white blotting paper was placed on the bottoms of the dishes to absorb excessive moisture.

Figure 1.—Center foliage of a coconut tree showing discoloration and fraying of the leaflets caused by larvae and adults of *Brontispa mariana*. The foliage was tied and removed in this manner for later study in the laboratory.

The eggs are laid between the leaflets on the upper or lower surfaces of the folded leaflets in the buds of the trees. They are light brown in color when first laid later changing to dark brown. Adults seem to prefer oviposition sites which are located intra-pinnately about 3 mm. above the midrib of the leaflets, but can lay eggs any place on the new growth. There was some indication that the females selected areas for egg laying near leaf areas which had already been fed on by beetles and where fermentation processes were in progress. The egg is lightly glued to the leaf surface, and the female beetle places a blob of frass or chewed-up leaf epidermis at the ends of each egg or group of eggs. Eggs may be laid singly or end to end in groups of from 2 to 6. Records were kept in the laboratory of the number of eggs laid at any one time and a summary of 395 laboratory records is as follows: 269 instances of one egg, or 68.1 per cent; 92 instances of 2 eggs, or 23.3 per cent; 25 instances of 3 eggs, or 6.3 per cent; 7 instances of 4 eggs, or 1.7 per cent; and 1 instance each of 5 and 6 eggs, or 0.3 per cent respectively. The duration

of the egg stage under Saipan laboratory conditions was six days, although an occasional egg would hatch in five days.

The larvae emerge through a slit at one end of the egg capsule. The slit is usually made laterally at a zone corresponding to the upper, tough portion of the egg, and the soft, underneath portion. In one instance it was noted that an interval of 30 minutes elapsed from the time the larva first started to emerge until it was free of the egg. It was observed that in certain instances the posterior hooks of the small larvae were used to enable them to separate the egg and thereby emerge. The small larva upon emerging from the egg usually proceeds to devour a portion of the egg shell before feeding on plant material. The larvae soon feed on coconut leaves eating long strips between the fibers. The larvae often feed together in large numbers and the entire surface of the leaf may become scarred and discolored. Larvae can feed between or within the leaflets.

In the laboratory the mean number of days for the larval period was 22.72 days with means for each instar as follows: first instar, 4.86 days; second instar, 3.38 days; third instar, 5.05 days; and fourth instar, 9.43 days. The variation in number of days for the duration of each of the instars was as follows: first instar, 3 to 8 days; second instar, 2 to 7 days; third instar, 2 to 8 days; and fourth instar, 6 to 16 days. Several days before pupation the larvae usually remain quiescent. The pupal period varied from 3 to 6 days with a mean of 5.14 days. Of a total of thirty-three individual rearings only seven were successfully completed. These varied from 30 to 36 days with a mean of 32.71 days. An average of all records, complete and incomplete, raised this figure to a mean of 33.68 days for the life cycle of the beetle from egg to adult in the laboratory at a mean temperature of 85° F.

Adults live for several months. One female started laying eggs on October 24, 1947, and died on December 22, having laid 113 eggs or an average of 1.88 eggs per day for the sixty-day period. Another female in 33 days laid 106 eggs or an average of 3.21 eggs per day.

Of 642 adults examined during this study, 343 were females and 299 were males, or a proportion of 1 male to 1.15 females, or a sex ratio of 0.58.

Generations of the beetle in the field were not definitely determined, although on the basis of the laboratory rearings, taking into consideration the maximum and minimum developmental periods, it would be assumed that 3 to 9 cycles occur a year. It was noticed that there was definitely a cyclic development of the beetles in individual trees so that there would be a preponderance of certain stages. Continuous generations occurred, and the longer life of the adults resulted in an accumulation of hundreds of them in a single tree.

HABITS AND INJURY.—The larvae and adults are positively thigmotropic and under most conditions negatively phototropic. Adults prefer not to fly, but under certain conditions fly to neighboring trees and spread the infestation. In the laboratory adults were observed to fly to the screen ventilator openings. Larvae in the laboratory were con-

tent to remain on folded leaflets as long as the food supply was adequate. Adults were observed to prefer to feed on the inside of the folded leaflets, feeding longitudinally between the fibers as in the case of the larvae and consumed strips 2 to 55 mm. long at a time. As is true for the larvae, the adults are semi-gregarious, congregating at the bases of the leaflets in large numbers. Mating is infrequently observed and apparently occurs chiefly at night. This was interesting in that it was noticed that *Brontispa depressa* in the Philippines mated frequently during the day. The adults have the interesting ability to move in any direction. The larvae are sluggish and prefer the darkened, interfolded leaves.

Figure 2.—Coconut tree on Saipan badly damaged by *Brontispa mariana.*

It was apparent on Saipan that the Mariana coconut beetle causes a slow decline of the trees resulting in a reduction in the yield of coconuts and an occasional death of a tree. A badly injured tree is shown in figure 2. A survey on Saipan conducted during October and November, 1947, indicated that only thirty-two per cent of the palms were bearing nuts, and most of these were not bearing sizeable clusters. The only other primary insect causing noticeable injury to coconut palms on Saipan during this survey was the red coconut scale, *Furcaspis oceanica* Lindinger.

HOST PLANTS.—The only known host plant of *Brontispa mariana* in the field is the coconut palm. In the laboratory it was found that both larvae and adults had a decided aversion for Chinese betel nut, *Areca catechu*, the only other common palm growing on Saipan, although in one instance a mature larva was able to complete its development on this plant. In one instance in the field on Saipan it was observed that a betel nut palm growing adjacent to an infested coconut palm was not infested with the beetle. A palmate-leaved palm, probably a *Eupritchardia* species, growing in the Agricultural Station on Saipan was infested in the laboratory and adults were reared from eggs laid on this plant.

SEASONAL ABUNDANCE IN RELATION TO CLIMATIC FACTORS.—Most species of hispid beetles feeding on the coconut palm cause more damage during dry periods than during periods of greater rainfall. This is due primarily to the more rapid rate of growth of the leaves during intervals of adequate rainfall. For this reason it would be expected that the Mariana coconut beetle would cause greater damage during dry seasons than during wet seasons. Rainfall would also probably restrict the migration of beetles, and tend to increase parasitic fungi. On the other hand the activities of parasites would be increased during dry periods. When the writer arrived on Saipan in October, 1947, there was severe and widespread damage to coconuts caused by the Mariana coconut beetle. It is interesting to note that from January to June, 1947, Saipan suffered an extended drought. During the period August to December, 1946, only 17.67 inches fell, and the annual rainfall on Saipan for 1947 at Tanapag was only 48.18 inches and over 30 per cent of this fell in October. In view of the importance of climatic factors to damage caused by this beetle the monthly mean average temperature and the monthly rainfall for 1947 and the first six months of 1948 are shown in the following tabulation:

Month	Mean Average Temperature °F.		Rainfall in Inches	
	1947	1948	1947	1948
January	79.7	79.8	2.45	4.47
February	80.2	78.2	1.12	1.48
March	81.0	78.9	1.40	3.68
April	81.0	80.1	1.26	4.52
May	81.8	81.3	1.90	2.53
June	82.4	82.3	1.21	3.22
July	82.0		7.80	
August	82.7		4.93	
September	81.8		5.49	
October	81.4		15.20	
November	82.2		4.00	
December	81.2		1.42	

Ordinarily there is a wet and dry season on Saipan, although it may not be marked, as rain may fall heavily during any month, and also there is a considerable variation depending upon where the observations are made. The wet season is usually from July to November and

the dry season from January to May. The mean average monthly temperature varies but little and so no great differences in rate of development of the beetle would be expected. Usually, however, it is warmer and there is a higher humidity from June to October or November. The humidity is usually high, with an average of 82 per cent relative humidity. Figures obtained at Tanapag for 1945 indicated an average relative humidity of 77.4 per cent, and for eight months in 1947, 80 per cent. With an average mean total developmental period of 33.86 days from egg to adult, assuming that the first eggs are laid in from 7 to 10 days, and assuming an average length of life of the beetle as 60 days, there would be an average of approximately five to six generations a year of *Brontispa mariana* on Saipan. Inasmuch as the average temperature for the laboratory was 85° F., which is higher than outdoor temperatures, and allowing for other variations, it is possible the number of generations could vary from over 3 to almost 9.

NATURAL ENEMIES.—No published records of parasites of the Mariana coconut beetle appear to be available. Oakley (1946) mentioned the occurrence of the earwig, *Chelisoches morio* (L.) in association with colonies of the beetle on every island he visited. An outstanding example of the biological control of a hispid beetle was reported by Taylor (1937). He reported the status of parasites introduced to control a leaf-mining hispid, *Promecotheca reichei* Baly in Fiji. Taylor mentioned the fact that the parasites attacking leaf-mining hispids do not ordinarily attack the externally-feeding species. For this reason the present investigation deals with parasites associated with externally-feeding hispids as it was thought that these would have the best possibility of selecting *Brontispa mariana*. Some selected references dealing with parasites associated with hispids feeding externally are tabulated below:

1923.[6] Corbett mentioned the occurrence of a chalcidoid egg parasite of *Plesispa reichei* Chap.

1929. Dammerman reported a parasite in Sumatra and the Malay peninsula destroying up to 60 per cent of the eggs of *Plesispa reichei* Chap.

1931. Ferrière described *Haeckeliania brontispae* from Java and Celebes.

1933. Ferrière reported *Pleurotropis detrimentosus* Gahan from larvae of *Plesispa reichei* Chap. in Java, and *Trichogrammatoidea nana* Zehnt. from the eggs of *Brontispa froggatti* (*B. longissima*) in the Solomon Islands.

1933. Ferrière described *Tetrastichodes plesispae* from *Plesispa reichei* in Java, and *Tetrastichodes brontispae* from Java and Dutch New Guinea, reared from *Brontispa longissima.*

1933. Risbec reported *Chelisoches morio* (L.) as a predator of *Brontispa froggatti* (*B. longissima*) in New Hebrides.

1934. Lever reported a small, gamasid mite, *Celaenopsis* sp. in association with the adult of *Brontispa froggatti* (*B. longissima*).

[6] References refer to those listed by author and date in "Literature cited" at the end of this paper.

1935. Awibowo reported the introduction of *Tetrastichodes brontispae* Ferrière to Celebes for the control of *Brontispa froggatti* var. *celebensis* (*B. longissima celebensis*) in March 1933. He listed the parasites of *B. longissima* in Java as follows: egg parasites, *Haeckeliania brontispae* Ferrière, 17 per cent parasitism, and *Ooencyrtus* sp., 10 per cent parasitism; and pupal parasite, *Tetrastichodes brontispae* Ferr., 60 to 90 per cent parasitism. He listed the parasites of *Plesispa reichei* Chapuis, as follows: egg parasite, *Ooencyrtus* sp., 23 per cent parasitism; larval parasites, *Pleurotropis detrimentosus* Gahan, 15 per cent parasitism, and *Tetrastichodes plesispae* Ferr., 10 per cent parasitism; and pupal parasite, *Tetrastichodes plesispae* Ferr., 60 to 90 per cent parasitism.

1936. Lever reported the control of *Brontispa longissima* in Celebes by *Tetrastichodes brontispae* from Java.

1937. Lever introduced *Tetrastichodes brontispae* from Java to the Solomon Islands to control *Brontispa froggatti* (*B. longissima*). Parasites were introduced during August and September, 1936, on Banika Island in the Russell group.

1941. O'Connor reported the importation to New Guinea of *Tetrastichus brontispae* (Ferrière) from the British Solomon Islands in 1939. He reported the presence of several natural enemies of *Brontispa longissima* in New Guinea as follows: a trichogrammatid egg parasite, a rare eulophid, a bacterial disease, and two mites, one an *Anoplocelaeno* sp.

1941. Johns reported that the parasites *Tetrastichus brontispae* and *Trichogrammatoidea nana* Zehnt. have become established in the Solomons, but have not given effective control.

The only natural insect enemy observed on Saipan and Rota prior to the introduction of other parasites was the earwig, *Chelisoches morio* (L.). On October 16, 1947, a mature earwig was caged with a mature *Brontispa mariana* larva. The earwig was immediately attracted to the larva, proceeded to feel it all over with its antennae, started chewing in several places, and finally began feeding on the dorsal part of the body just behind the head. In fifty-two minutes the larva was completely consumed. This earwig was found to be very abundant in practically all coconut trees examined, but played no observable role in reducing numbers of the beetles. The hypopi of tyroglyphid mites were commonly attached to the undersides of the elytra of beetles on Saipan, but there was no indication that they caused injury to the beetles. A fungus disease of the adult beetles was found on Rota on October 18, 1947. It was determined as a *Metarrhizium* species,[7] and was considered as secondary and of minor importance at this particular time. That fungus diseases could play a part in the control of hispid beetles is indicated by the work of Reyes (1932) on *Promecotheca cumingi*.

FIELD SEARCH FOR PARASITES.—A week was spent in the vicinity of Los Baños, Luzon, Philippine Islands, searching for parasites. Two exter-

[7] Determined by Dr. E. A. Steinhaus.

nally-feeding hispid beetles were found as follows: *Brontispa depressa* Baly[8] on *Arenga pinnata*, at Los Baños (October 22, 24, 1947) and San Pablo (October 25); and *Plesispa reichei* Chapuis on coconut at San Pablo (October 23), Los Baños (October 24), and on *Arenga pinnata* at San Pablo (October 25). No evidence of the presence of parasites was found, and there was no later emergence of parasites from caged material.[9] An infestation of the coconut leaf-mining hispid, *Promecotheca cumingi* Baly, was observed near San Pablo, and of 100 eggs examined 78 showed the presence of parasitism.

In Malaya, headquarters were established at Kuala Lumpur, Selangor, Federation of Malaya. Parasites were found associated with *Plesispa reichei* Chapuis, *Plesispa nipae* Maulik, and *Wallaceana palmarum* (Gestro), and two of the parasites were shipped to Saipan or taken there personally by the writer. *Plesispa reichei* was found attacking young coconut trees at numerous localities, but was also found selecting *Crytostachys lakka, Oreodoxa regia, Nipa fruticans,* and an *Arenga* species. An egg parasite of this beetle, *Ooencyrtus podontiae* Gahan[10] was found at the following localities: on coconut at Kuala Lumpur, collected December 18, 1947, one egg of 9 collected was parasitized; on coconut at Klang, collected December 24, 1947, two eggs of 8 collected were parasitized, and at the same locality on December 26, 2 of 14 eggs were parasitized; on coconut at Serdang, collected December 23, 1947, one of 10 eggs was parasitized; and on *Crystostachys lakka,* at Kuala Lumpur, collected December 18, 1947, one of 2 eggs collected was parasitized and the parasite emerged January 1, 1948. One egg of *Plesispa reichei* collected on coconut at Kuala Lumpur on December 18, 1947, was found on January 14, 1948, to have four emergence holes and one adult recovered was determined as *Haeckeliania brontispae* Ferrière. In the laboratory it was found possible to rear *Tetrastichus brontispae* (Ferrière) from pupae of *Plesispa reichei* (see plate 1B). Adults of this parasite from Java readily selected one- to two-day-old pupae of this beetle. No field collections of this parasite from *Plesispa reichei* were made.

Plesispa nipae Maulik in Malaya was found attacking *Nipa fruticans* at Kuala Selangor, Kapar, and Klang, and this hispid was attacked by several parasites (see plate 1C and 1E for larva, pupa and adults). The commonest parasite, particularly in the Klang area, was an egg parasite, *Haeckeliania brontispae* Ferrière, which parasitized an average of 60 per cent of the eggs during December 1947 and January 1948. The fact that the eggs of this beetle are laid side by side in groups and are concentrated in certain localized areas on the plants may explain in part the high degree of egg parasitism. The eggs of *Plesispa reichei,* for example, are more widely scattered on the plants, and it was difficult to collect large numbers of parasitized eggs in the field. The eulophid parasite, *Tetrastichus brontispae* (Ferrière), was collected occasionally from *Plesispa nipae* larvae and pupae, and the records are as follows:

[8] Hispid beetles in this paper determined by H. S. Barber, G. E. Bryant and S. Maulik.
[9] Letter to writer from Dr. C. M. Cendaña dated December 31, 1947.
[10] Parasites in this paper determined by A. B. Gahan.

at Kapar on the Kuala Selangor Road (January 6, 1948), one pupa of 8 collected was parasitized, and 2 pupae died, and a second collection at the same locality (January 19, 1948) gave a count of 43 parasitized pupae of 75 pupae collected, and 2 parasitized larvae were found; on the road to Kuala Selangor (January 1, 1948), one pupa of 8 collected was parasitized; and at Klang (December 26, 1947) one parasitized pupa was collected. Two other parasites of *Plesispa nipae* were reared as follows: an *Achrysocharis* species (probably the same as the one from *Wallaceana palmarum*) was reared from a larva collected January 1, 1948, on the road to Kuala Selangor; and a *Tetrastichus* species (not *brontispae*) was reared from a pupa collected at Kapar, January 6, 1948.

The hispid, *Wallaceana palmarum* (Gestro), was collected in Malaya on *Nipa fruticans, Areca catechu, Eugeissona triste, Metroxylon sagus,* an unidentified palm in the Klang area with persistent leaf bases, and an unidentified spiny palm at Ulu Langat. This beetle occurs in association with *Plesispa nipae* on *Nipa fruticans,* but its preferred host seems to be *Areca catechu* where the larvae and adults feed on the new central growth and on the protected bases of the leaf stalks. An *Achrysocharis* sp. was found to be a larval parasite in one small area at Ulu Langat, in collections made from December 27, 1947, to January 13, 1948. Of 44 mature larvae collected December 27, 1947, eight larvae were parasitized, and from 6 to 32 parasites emerged from a single larva with a proportion of sexes of one male to 7 females. At this time a larva of a predaceous beetle was found feeding on the pupae of the *Achrysocharis* species.

Five additional unidentified species of externally-feeding hispids were collected in Malaya, and with one exception there was no indication of parasites. On February 1, 1948, at a locality 7 miles south of Klang, adults, eggs, and larvae of a *Wallaceana* species[11] were collected on *Zalacca conferta.* One mature larva was discolored and swollen, and had parasite emergence holes not unlike the condition observed for the *Achrysocharis* species attacking the larvae of *Wallaceana palmarum.*

Parasites were found more abundantly in Malaya on palms where vines held the leaves together, making ideal conditions for the beetles. This condition is shown in figure 3.

No search for the parasites of *Brontispa longissima javana* Weise and *B. longissima celebensis* Gestro in Java was necessary as the parasites were well known and at least two species had been reared in the laboratory of the Instituut voor Plantenziekten at Buitenzorg. The eulophid *Tetrastichus brontispae* (Ferrière)[12] had been previously shipped to Celebes from Java, and a breeding program was initiated to breed this parasite for introduction to Saipan and Rota. The egg parasite, *Haeckeliania brontispae* Ferrière,[13] was also secured in Java in limited numbers.

[11] Determined as *Wallaceana phoenicia* Mik. (Maulik, 1949).

[12] *Tetrastichodes* Ashm., which is used commonly for this species is synonymous with *Tetrastichus* Hal. according to A. B. Gahan in Proc. U. S. Nat. Mus., 1916, p. 168; Burks, in Proc. U. S. Nat. Mus., 93:510, also treats it as a synonym.

[13] The original spelling by Girault was *Haeckeliania,* but recent authors have been using *Haeckeliana* which is incorrect as it refers to a genus in the Protozoa. (See Neave, Nomenclator Zoologicus, 2(D-L):544.)

Eighteen collections of *Brontispa longissima* in the vicinity of Buitenzorg, Java, collected from December 31, 1947, to January 28, 1948, involving 1,769 larvae and 640 pupae gave no determinable parasitism of

Figure 3.—A leaf of *Nipa fruticans* growing near Klang in Malaya encircled by a climbing vine. This condition creates an excellent habitat for *Plesispa nipae* with resultant increase in parasite activity.

the larvae and an average of 16 per cent pupal parasitism by *Tetrastichus brontispae*. Of 1,002 adult beetles collected, 830 were the subspecies *javana* and 172 were *celebensis*. There was a wide range in the percentage of parasitism in a single tree, in fact it varied from no parasitism to 100 per cent parasitism of the pupae. The fact that these collections were made during the rainy season probably accounts for the low average per cent parasitism. In these collections it was not determined if mature larvae were parasitized prior to pupation.

Records in the Buitenzorg collection indicate that the egg parasite of *Plesispa reichei* is *Ooencyrtus corbetti* Ferrière (Buitenzorg, Java, 28-VI-32, and XII-35) and the egg parasite of *Brontispa longissima* is *Ooencyrtus podontiae* Gahan (V-31, and 1932, det. Muesebeck), the same egg parasite found in Malaya. An *Ooencyrtus* species egg parasite is also recorded from the hispid, *Botryonopa marginata* (Medan, Sumatra, 1935, det. Gahan).

PROPAGATION OF TETRASTICHUS BRONTISPAE (FERRIERE).—This eulophid parasite is almost black in color with greenish reflections, and antennae and legs are yellowish to brown, and it ranges in size from 0.8 mm. long to 1.4 mm. long. The duration of the life history was from 16 to 20 days during this study, and from 8 to 20 parasites emerged from a single pupa. The females select mature larvae or one- to two-day-old pupae, and in 5 days the pupa begins to clear and the parasite larvae can be seen moving inside. The beetle pupa begins to extend and becomes translucent, and toward the end of the developmental period the black parasite pupae can be seen inside. In emerging, holes are cut through the pupae and the adults crawl out. An occasional parasitized beetle larva does not pupate, and in this case the parasites emerge through the larva, but usually parasites emerge through the pupae.

In Malaya little attempt was made to breed *Tetrastichus brontispae*. Adults of this species emerging in Malaya from parasitized pupae of *Brontispa longissima* were found to select one-day-old pupae of *Plesispa reichei*. Parasites emerging from *Plesispa reichei* on Saipan from such a rearing were exposed to *Brontispa mariana* pupae, and adults were reared. These observations indicated that this parasite was not too selective within the genera *Brontispa* and *Plesispa*, a fact which was of considerable importance in its transfer to *Brontispa mariana*.

In Java *Tetrastichus brontispae* was propagated by exposing one- to two-day-old pupae to the parasites in glass tubes using about 15 *Brontispa* pupae to 15 to 25 adult female parasites. A 50:50 mixture of honey or sugar and water was used to feed the parasites, which was placed as small droplets on a piece of coconut leaf inside each tube. To maintain a high humidity a small piece of moistened absorbent paper was placed in each tube. A low wattage incandescent lamp placed in proximity to the rearing tubes was found to stimulate parasite activity and egg laying. An exposure period of 24 hours was given, after which the pupae were removed. In 5 to 6 days the degree of parasitism could be noted. Natural mortality varied from 10 to 25 per cent. Pupae were found to be more easily handled than larvae in the breeding work. A total of 572 para-

sitized pupae were secured in Java and later shipments were made directly to Saipan from Buitenzorg.

Parasites from Java emerging on February 9, 1948, on Saipan were caged with pupae of *Brontispa mariana* and on February 27 the first parasites emerged. The parasites were reared by methods similar to those already described. Fifteen exposures of pupae were made and the last parasites emerged in the laboratory on Saipan on April 2, 1948. In the laboratory on Saipan at an average mean temperature of 85° F. the developmental period for *Tetrastichus brontispae* varied from 16 to 19 days with an average of 17.75 days. That shorter periods of exposure would be possible was indicated when 3 two-day-old pupae were exposed for one hour with 20 female parasites, and on March 1 parasites emerged from all the pupae. On Saipan the parasites were found to oviposit in both the dorsal and ventral areas of the pupae, but they seemed to prefer intersegmental areas as oviposition sites. Parasites to be released were fed and mated before they were released.

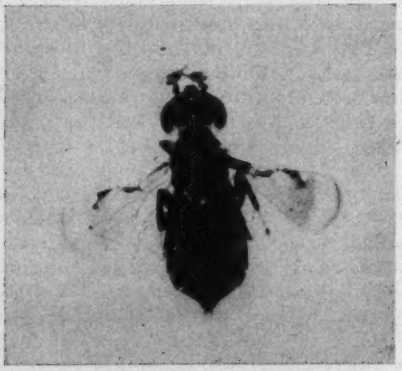


Figure 4.—Adult female of *Haeckeliania brontispae* from Malaya, × 29.

PROPAGATION OF HAECKELIANIA BRONTISPAE FERRIERE.—This small trichogrammatid egg parasite, ranging in size from 0.5 mm. to 0.93 mm. long, is dark brown and the wings are pale fuscous with a terminal clear band (see figure 4). Usually one parasite emerges from a single egg, but apparently races of this insect occur where several usually emerge from a single egg. Newly laid eggs are preferred as oviposition sites. Host eggs include those of *Brontispa longissima, Plesispa nipae,* and *Plesispa reichei.* Specimens from Java were found to select and complete their development in eggs of *Brontispa mariana,* and Malayan specimens were found to oviposit and complete their development in eggs exposed in the laboratory. One female was observed on Saipan to oviposit for a period of four minutes in one egg of the coconut beetle. Certain females were found to oviposit a second time in the same egg. In mating the male climbs on the back of the female and brings his

abdomen underneath to engage the female, and in this position the male may be carried about by the female. Adults fed readily on a 50:50 mixture of honey and water. One female from Malaya was observed to live in the laboratory on Saipan for a period of 14 days.

No attempt was made to propagate large numbers of this egg parasite, as eggs collected in Malaya were 60 per cent parasitized. Certain rearings were made however in the laboratory on Saipan using eggs of *Brontispa mariana* and these are given in the following tabulation:

Date Exposed	Number of Eggs Exposed	Number of Parasites	Date Emerged	Number Emerged
February 8	40	25	February 26	2
February 9	4	25	March 1	1
February 10	31	25	March 1	1
February 12	14	10	March 5	1
February 14*	15	5	March 8-10	12
February 15*	15	5	March 16	2
February 16	8	15	March 10	1
March 9	40	6	March 27-29	5

* Parasites from Java, the rest from Malaya.

The developmental period of these rearings varied from 16 to 30 days with an average of 21.4 days. If the two rearings of the Java parasite are excluded it is observed that the average developmental period from egg to adult is 19.6 days, whereas it averages 27 days for the Java strain. The eggs were usually exposed to the parasites for a 24-hour period, although in the case of the February 9 rearing, the 4 eggs were exposed to 25 parasites for one hour. One-day-old eggs were found to be more readily selected by the parasites. In these rearings only a 15 per cent recovery of parasites was obtained as of a total of 167 eggs exposed only 25 parasites emerged. It was observed that a number of parasites dried up inside the eggs and failed to emerge, and on numerous occasions tyroglyphid mites were found inside the eggs.

INTRODUCTION OF PARASITES TO SAIPAN AND ROTA.—Two parasites were successfully introduced to Saipan and Rota, namely the larval and pupal parasite, *Tetrastichus brontispae* (Ferrière), and the egg parasite, *Haeckeliania brontispae* Ferrière, which were both introduced from Malaya and Java. The first shipment of parasites was made from Malaya in Janury 1948 by plane, and as a result, 125 egg parasites and 75 *Tetrastichus* were liberated by D. B. Langford and R. Reif on Saipan. A third parasite, *Achrysocharis* sp., from *Wallaceana palmarum,* did not survive. A shipment of 572 parasitized pupae obtained in Java containing *Tetrastichus* was taken by plane to Saipan by the writer, along with 2,400 parasitized *Plesispa nipae* eggs containing *Haeckeliania,* a few *Haeckeliania* from Java on *Brontispa longissima,* and a few larvae and pupae of *Plesispa nipae* parasitized by the Malayan strain of *Tetrastichus.* The first *Tetrastichus* parasites from this shipment were liberated on Saipan on February 7, 1948, and approximately 1,000 parasites were reared from pupae of *Brontispae mariana* in the Saipan laboratory. One- and two-day-old pupae of *Brontispa mariana* were readily selected in the laboratory

by both the Java and Malayan strains of *Tetrastichus*. Two later shipments of *Tetrastichus* were received on Saipan from Java, and the parasites were liberated and used in the laboratory rearings. One was received March 10, 1948, and the second was received by D. B. Langford and liberated on Saipan from April 23 to 30, 1948. A total of 5,285 *Tetrastichus* parasites were liberated during the period January 16 to April 30, 1948, of which 250 were released on Rota. A total of 25 liberations were made on Saipan and an attempt was made to place them in the more important coconut growing areas on the island. Each liberation was made in from 1 to 5 trees. An attempt was made to place the parasites in trees showing a preponderance of mature larvae and pupae. A total of 332 *Haeckeliania* egg parasites were released during the period January 14 to March 29, 1948. Of this number 50 were released at one locality on Rota. A total of only 14 egg parasites of the Java strain were released, and only 8 of the Malayan strain which had been reared from *Brontispa mariana* eggs on Saipan. Ten liberations of egg parasites were made.

ESTABLISHMENT OF PARASITES.—Observations were made of a young coconut tree at Magicienne Bay on Saipan where parasites were liberated February 7, 1948, to record the establishment of *Tetrastichus brontispae*, and the following tabulation indicates the results obtained:

Date of Observation	Number of Pupae Collected	Per cent Parasitism
February 14	4	100.0
February 28	8	12.5
March 3	3	33.3
March 11	4	100.0
March 19	1	100.0

It was apparent from these initial observations, even though the numbers involved are not statistically significant, that this parasite had already completed two generations in the field on *Brontispa mariana*. The egg parasite was not recovered in the field although on March 19 at Magicienne Bay 2 eggs of 6 examined yielded dead egg parasites when examined under the microscope, and one egg was found with a round emergence hole similar to *Haeckeliania*. Recent observations indicate that the larval and pupal parasite, *Tetrastichus brontispae* is established on Saipan and Rota and is effectively controlling *Brontispa mariana* with an overall parasitism on Saipan by November 1948 of 60 per cent. The egg parasite, *Haeckeliania brontispae*, has not been recovered and it is assumed that it did not become established.

SUMMARY.—The Mariana coconut beetle, *Brontispa mariana* Spaeth, was first found on Saipan about 1931, and since this time has almost completely eliminated a sizeable copra and coconut oil industry. The United States Navy requested the Pacific Science Board to investigate the possibilities of controlling this insect so that the industry could be restored for the benefit of the natives. The genus *Brontispa* is widely

distributed in the Austro-Malayan area, and *B. mariana* is found in the Mariana and Caroline Islands. Detailed descriptions of the egg, larva, pupa and adult are given. This beetle is an externally-feeding hispid beetle attacking both as larvae and as adults the central unfolded leaves, causing dark blemishes which persist and reduce the general health of the tree. The tree usually fails slowly, produces only a few, if any, coconuts and may finally die. Details of the life history are presented and the mean average number of days for development from egg to adult was found to be 33.68 days with an adult life of several months. Continuous generations occur and it was estimated that there are from 3 to 9 generations a year, with an average of 5 to 6 generations. The only known host in the field is the coconut palm, although beetles were able to complete their development on a *Eupritchardia* species. Prior to the introduction of parasites the only known enemies were the earwig, *Chelisoches morio* (L.) and a fungus disease, *Metarrhizium* sp. A review is presented of the literature dealing with parasites affecting externally-feeding hispid beetles. A search for parasites in the Philippines, Malaya and Java resulted in the introduction of the larval and pupal parasite *Tetrastichus brontispae* (Ferrière), and the egg parasite, *Haeckeliania brontispae* Ferrière both of which were introduced from Malaya and Java. Other parasites collected in Malaya were a larval parasite of *Wallaceana palmarum* and *Plesispa nipae,* an *Achrysocharis* sp., a *Tetrastichus* sp. from pupae of *Plesispa nipae,* and an egg parasite of *Plesispa reichei, Ooencyrtus podontiae* Gahan. A total of 5,285 adult parasites of *Tetrastichus brontispae* were liberated on Saipan and Rota, of which 1,000 specimens were reared from *Brontispa mariana* on Saipan and the others were brought directly from Malaya or Java. About 332 adults of the egg parasite, mostly brought directly from Malaya, were liberated on Saipan and Rota. Parasites were released on Saipan and Rota during the period January 16, 1948, to April 30, 1948. Field observations made up to March 19, 1948, indicated that at this time the *Tetrastichus* parasite had completed two generations in the field on *Brontispa mariana* on Saipan. Recent observations indicate that *Tetrastichus* is well established in all of the major coconut-growing areas on Saipan, and on Rota, and by November 1948 on Saipan had an overall parasitism of larvae and pupae of *Brontispa* of 60 per cent.

ACKNOWLEDGEMENTS.—The writer is indebted to a number of individuals and groups for assistance during the course of these investigations. H. J. Coolidge and other members of the Pacific Science Board have given encouragement throughout the investigations and have handled the multitudinous details connected with field travel. The Insect Control Committee for Micronesia, C. E. Pemberton, Harry S. Smith, and C. P. Clausen, have made valuable suggestions during the investigations. The United States Navy by furnishing transportation, equipment and personnel assistance, is responsible for the success obtained in securing the parasites. I am particularly indebted to Admiral C. H. Wright, formerly Deputy High Commissioner, Trust Territory of the Pacific Islands, and his staff, Commander R. A. Wilhelm and his staff,

Captain G. L. Compo and his staff, D. B. Langford, staff entomologist, Frank Brown of the Agricultural Station on Saipan, and Lieutenant H. S. Phipps. Certain individuals or institutions assisted in securing beetles or parasites in the field, particularly C. M. Cendaña of the Philippine College of Agriculture, H. T. Pagden and R. J. A. W. Lever of the Malayan Department of Agriculture, and J. van der Vecht of the Institute of Plant Diseases and Pests, Buitenzorg, Java.

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The Artificial Culture of Fruit Flies and their Parasites[1]

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(Presented at the meeting of December 12, 1949)

In the laboratory study of any insect it is necessary to maintain an adequate supply of the desired stages for experimental use. This is particularly true of the oriental fruit fly (*Dacus dorsalis* Hendel), which is difficult to obtain in quantity from natural infestations during the winter months, when host fruits are scarce and larval and adult populations of the fruit fly are at a low ebb. It has also become increasingly difficult to obtain for experimental purposes oriental fruit fly larvae reasonably free from natural parasitization by *Opius longicaudatus* (Ashmead) and *O. persulcatus* (Silvestri).

Studies were therefore undertaken to determine the practicability of culturing fruit flies (Tephritidae) and their parasites on agar-base media, as suggested by Mainland.[2]

FRUIT FLY CULTURE—Initial attempts to induce oviposition by *Dacus dorsalis* directly on agar media were largely unsuccessful, and larval development was found to be inhibited by undesirable molds introduced with the adult flies. Subsequent studies were conducted with known numbers of eggs or newly hatched larvae transferred to the media with a camel's-hair brush. Eggs were obtained from sections of orange peel fastened to glass plates with paraffin and placed in cages with gravid flies according to the techniques used in earlier studies on the Mediterranean fruit fly. When larvae were desired, the eggs were held on moist blotting paper until they hatched. The larvae were then reared in petri dishes containing about ½ inch of an agar medium. When the larvae were ready to pupate, the dishes were opened and placed at an angle over moist sand in battery jars. The puparia formed by the larvae entering the moist sand were screened out at intervals and held for emergence. It was also found that the agar media could be poured on sections of ¼-inch-mesh hardware cloth, which allowed the mature larvae to fall directly on the sand.

Fifteen agar formulas were tried, all based on the standard Texas *Drosophila* formula.[3] Variations included the use of apple sauce, guava juice, and Spam in place of banana, differences in the amount of agar, some media without yeast and/or sucrose, some with double the amount of yeast, and others with only one of the mold inhibitors or with none at all.

[1] Approved by Avery S. Hoyt, Associate Chief, Bureau of Entomology and Plant Quarantine, for publication as Bureau manuscript No. 9673.

[2] Hawaii Agr. Expt. Sta. Rpt. 1946-48, p. 66.

[3] To make 1 liter use 760 cc. of water, 20 grams of bacto-agar, 220 cc. of banana pulp, 30 grams of dried yeast, 20 grams of sucrose with 3 cc. of proprionic acid and 2.4 cc. (0.18%) of Moldex as mold inhibitors.

Although most of these tests were limited in scope, they clearly indicate the practicability of culturing *Dacus dorsalis* on agar-base media. On the complete Texas formula the larvae developed and pupated normally, producing larger than average puparia and adult flies normal in every respect. Survival was also high in the best series, as many as 80 to 100 per cent pupating and about 60 to 70 per cent of the introduced larvae reaching the adult stage.

It was found that yeast is essential for larval development. In fact, agar media with yeast alone gave nearly as good results as the fruit-yeast mixtures, whereas very little development occurred on banana-agar without yeast, as shown in Table 1. In these tests the yeast and all other ingredients were boiled for 3 minutes. The results indicate that the protein furnished by dead yeasts is entirely adequate for larval nutrition. It appears likely that in nature fruits are merely the substrata for yeasts and other microorganisms from which the larvae derive most of their nourishment.

Table 1.—Development of Dacus dorsalis on Three Agar-Base Media[4]

Medium	Per cent Pupating	Average Weight of Puparia (mg.)	Remarks
Complete Texas	91	15.8	Mostly subsurface feeding; development rapid.
Yeast-agar-water	80	13.8	Mostly subsurface feeding; development rapid.
Banana-agar-water	28	6.0	Fed mostly on surface scum; development slow; puparia pale.

[4] 200 newly hatched larvae (4 replicates containing 50 larvae) in each series.

A surface scum of unknown origin sometimes appeared on the cultures, occasionally causing high mortality to small first- and second-instar larvae but rarely to those of larger size. If the scum did not develop when the larvae were very small, it rarely became established, and it seemed to appear first on portions of the media on which they had not fed. It was most prevalent when larvae hatching from eggs taken from field-collected fruit were cultured, but it also occurred in laboratory cultures. With high larval populations (100 or more per dish) the surface scum caused little or no mortality. The crowded larvae may have been able to ingest the scum more rapidly than it could develop, or they may have secreted some antibiotic agent which checked its growth.

Quantitative studies have indicated that when more than 100 newly hatched larvae are placed in a 3½-inch petri dish containing about 30 grams of medium, the larval period is prolonged and the puparia are undersized. The optimum concentration is about 50 to 100 larvae per dish, or 2 to 4 larvae per gram of medium.

The larvae of *Dacus cucurbitae* Coquillett and *Ceratitis capitata* (Wiedemann) were also reared with equal facility on the same agar-base media, including the yeast-agar-water formula. In fact, they appeared to develop

more rapidly therein and to produce larger flies than in most field-collected fruits. This method therefore shows great promise for rearing all three species of fruit flies occurring in Hawaii. The present need, however, is for a mass-inoculation technique that will eliminate the individual transfer of eggs or larvae to the cultures. With this improvement quantity production in large-scale units should be entirely feasible.

PROPAGATION OF PARASITES—Numerous experiments were conducted to determine whether the parasite *Opius longicaudatus* can be propagated on *Dacus dorsalis* in agar-base media. Adult parasites of different ages and numbers were confined for varying periods in cylindrical glass cages over the culture dishes. At first the parasites became entangled in the wet media, but this difficulty was overcome by using a firmer agar (3 per cent) and a cheesecloth covering over the surface which enabled the parasites to oviposit through the meshes.

The oriental fruit fly cultures in agar-media are apparently unattractive to the parasite until the adults are at least 6 days old. After this time, however, the females oviposited very readily and produced a generally high degree of parasitization (Table 2), although the progeny were predominantly males. No female progeny were obtained from parasites more than 10 days of age. In these experiments three replicates of 10 newly hatched male and female *Opius longicaudatus* were caged over agar cultures containing 50 half-grown larvae, the same parasites being transferred to new cultures at 2-day intervals. At the end of 12 days the remaining 9 female and 7 male parasites were placed in a single cage, and they were transferred to new cultures at 2-day intervals until the 18th day, when only 2 of the original 30 females were still alive.

The addition of fruit juices and extracts and 0.5 per cent of pyridine to the cheesecloth patches over the agar did not increase the attractiveness of the cultures or the degree of parasitization.

Table 2.—Propagation of Opius longicaudatus on Dacus dorsalis in Agar-Base Media

Age of Parasites, Days	Per cent Parasitized	Per cent of Females Reared
0- 2	0	-----
3- 4	0	-----
5- 6	0	-----
7- 8	51.3	10.3
9-10	82.2	36.8
11-12	76.3	0
13-14	94.7	0
15-16	54.5	0
17-18	40.0	0

When cultures containing newly hatched first-instar oriental fruit fly larvae were exposed to *Opius longicaudatus,* parasitization was at least equal to that obtained from exposures of second and third instars. The smaller host larvae also produced a higher ratio of female parasites. In

other tests *O. longicaudatus* was found capable of parasitizing *Ceratitis capitata* in agar media.

The cynipid parasite *Trybliographa* sp. from Malaya and *Tetrastichus dacicida* Silvestri from Africa were also readily propagated on both *Dacus dorsalis* and *Ceratitis capitata* larvae developing in agar-base media. No progeny of these parasites were obtained from *D. cucurbitae* larvae, although they were attacked with equal readiness. These parasites are attracted to the media without delay and are able to work in and upon it without difficulty.

The Larva and Pupa of Brontispa namorikia Maulik (Coleoptera: Chrysomelidae: Hispinae)

By S. MAULIK

BRITISH MUSEUM (NATURAL HISTORY)

(Presented by Mr. Van Zwaluwenburg at the meeting of December 12, 1949)

In the Annals and Magazine of Natural History, (XI) 13:498-502, July, 1946 (actually published June 25, 1947) I described this species from three specimens collected in the Marshall Islands. Through the courtesy of Elwood C. Zimmerman, Experiment Station, H.S.P.A., I have now had the opportunity of studying 19 larvae, 8 pupae and 45 imagos of the same species, collected in Kusaie, Caroline Islands, July 26, 1947 by D. B. Langford while on a survey for the Pacific Science Board, National Research Council. Part of this material has kindly been presented to the British Museum by Mr. Zimmerman.

The drawings were made at the British Museum (Natural History) by Arthur Smith and have been supplied by Mr. Zimmerman. During my illness this note was prepared for publication from my manuscript notes by Mr. Leslie Bairstow of the British Museum, to whom my thanks are due.

In the Proceedings of the Zoological Society of London, (B) 108:49-71, 1938, I published a revision of the genus *Brontispa*. In that paper, food-plants, geographical distribution and relationships of all known species of *Brontispa* were discussed. All species except two are from islands of the Pacific Ocean; the exceptions are, one species from Mauritius and one from Rodriguez in the Indian Ocean. In the same paper, larvae of three species were described. *B. namorikia* is therefore the fourth species of *Brontispa* of which the larva is now known. It is the third of which the pupa is described.

Nepionotype: In the British Museum (Natural History).
Neanotype: In the British Museum (Natural History).
Food-plant: Coconut palm.

LARVA

FORM OF BODY—Elongate, parallel-sided, with ten lateral projections on each side, twenty in all. All segments of body well-marked.

COLOR—Alcohol specimens cream, upper side browner than the underside. Tail-shovel, lateral projections, head and thoracic segments slightly lighter. No pattern or markings on the body.

NUMBER OF SEGMENTS IN THE BODY—Head 1 + thorax 3 + abdomen 8 = 12 segments. The tail-shovel may represent a ninth segment of the abdomen.

NUMBER OF SPIRACLES—Pro-mesothoracic 1 pair + abdominal 8 pairs = 9 pairs. The thoracic spiracle projects between the pro- and mesothorax.

In abdominal segments 1 to 7 each spiracle is situated in the middle of a lateral area of a tergite, not far from the base of the corresponding lateral projection. The eighth tergite has no spiracle, the spiracles of the last abdominal pair being situated at the concavity of the tail-shovel, on the edge of its basal slope and separated from each other by the width (1 mm.) of the concavity of the tail-shovel. The opening of every spiracle has a circular rim.

HEAD—Broader than long, as broad as the base of the prothorax, with a well-formed cranium, but not very convex above; three sutures, two oblique and one longitudinal, meeting on the basal area, but not in a clearly-defined manner. In front between the upper condyle of the mandible and a group of ocelli is a two-segmented antenna, its basal segment having a circular area ringed with a dark line, and its apex having only a small papilla. There is a group of five ocelli, three in a line and two in another line parallel to it; the ocelli are black except that owing to lack of pigment one is not seen in some specimens. Labrum, two mandibles (each with two teeth), two maxillae (with two palpi) and labium (with two palpi) are well-developed.

DORSAL ASPECT OF THORAX—Prothorax slightly narrower than mesothorax, broader than long, lateral margins rounded without any process, upper surface with many fine parallel transverse ridges extending from side to side. Mesothorax broader than long, upper surface with one short fold across the middle; each lateral margin with a well-developed process. Metathorax almost equal to mesothorax in length and breadth, upper surface with one short fold across the middle; each lateral margin with a well-developed process.

VENTRAL ASPECT OF THORAX—Leg well-developed, two-segmented, terminating in a sharp claw; opposite the claw is a pulvillus.

DORSAL ASPECT OF ABDOMEN—First to seventh abdominal segments similar to one another, nearly equal to one another in length and breadth; eighth segment narrowed to the tail-shovel; each lateral margin of each segment with a well-developed process. A cleared specimen appears to show each abdominal tergite as having a transverse fold across the middle and, on tergites second to seventh, a row of widely-spaced spinules parallel to, and in front of, the furrow and a second row behind the furrow including four spinules rather evenly and closely spaced. On close examination of this cleared specimen, however, the transverse fold and spinules appear to relate to a second surface very slightly below the true outer surface; in uncleared specimens there seems no external indication of furrow and spinules except that towards the lateral parts of the tergites some spinules appear to show through the surface from below. The explanation for this is obscure. In any event, the first and eighth tergites show no appearance of such major spinules, but all abdominal tergites, especially towards their lateral margins, are covered with very minute spinules which give them a shagreened appearance.

VENTRAL ASPECT OF ABDOMEN—Across the middle of each of the ventrites from fourth to seventh—one series of six spinules; beyond these on each side but not on the same line—two spinules; altogether, ten spinules. The spinules on the seventh ventrite are smaller. The median spinules are stronger than corresponding spinules on the tergites. Anus situated in the middle of the eighth ventrite.

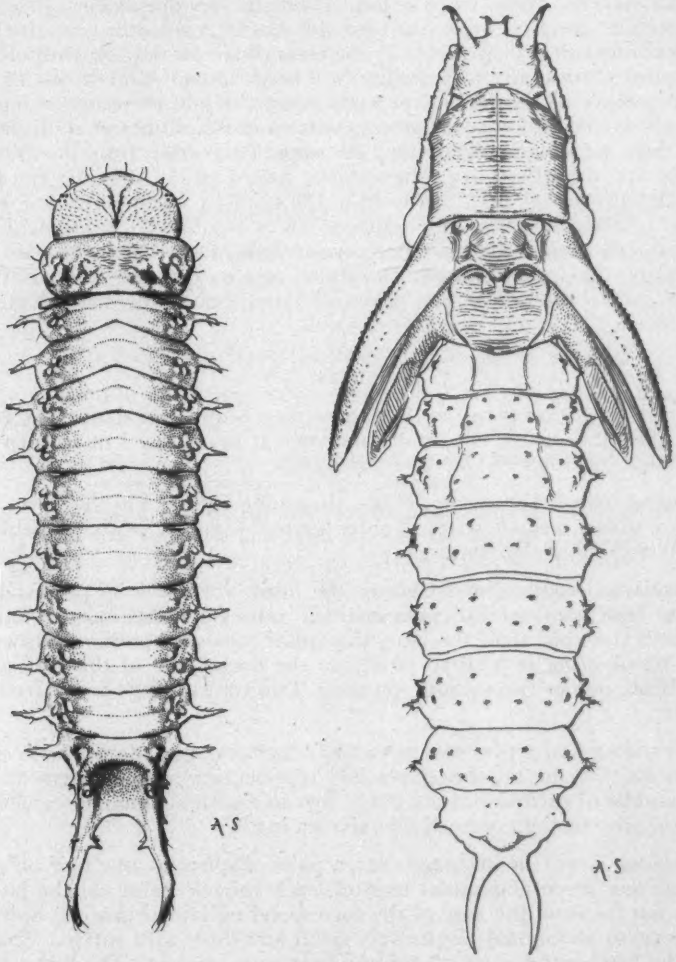

Figure 1.—Larva, drawn from an uncleared specimen 5.6 mm. in length, and pupa, drawn from a cleared specimen 7.0 mm. long, of *Brontispa namorikia* Maulik.

LATERAL PROCESSES—Compared with the size of the larva each lateral process is short, and in this species the processes are all nearly equal to one another. They are round in cross-section, thicker at the base, tapering towards the apex, with the surface wrinkled. On each side their arrangement is as follows: Prothorax 0 + mesothorax 1 + metathorax 1 + abdomen 8 = 10 processes.

TAIL-SHOVEL—About twice as long as broad; very deeply emarginate in the middle; dorsally concave at base, the concavity smooth; ventrally flat. Each of the two prongs enclosing the emarginate portion bent inward in its apical portion and terminating in a small spine. As each side of the basal portion of the tail-shovel has a certain depth, there are an upper and a lower edge along each prong on its outer side, although on its inner side there is only one edge. Along the upper outer edge: from the spiracle to the apical portion, five spines widely spaced and of unequal size (the middle ones being larger); in front of the spiracle, a group of three small spines. Along the lower outer edge: seven or eight widely and unequally spaced spines, those on the basal portion being larger than those on the apical portion. On the inner margin of each prong: two comparatively large spines, one above the other, situated nearer the base than the middle.

PUPA

SPECIAL FEATURES—In the head, antennae, wings and thorax the pupa resembles the imago, but in the abdomen it has features of its own not possessed by either the larva or the imago.

COLOR—Alcohol specimens cream, underside lighter. On the upper surface a broad median stripe, lighter than the lateral areas particularly of the abdominal segments.

HEAD—In front on each side of the head, a fairly long process (the pupal equivalent of the interantennal process of the imago), darker towards the apex than the base, the apical portion bending downwards and terminating in a sharp point; on the dorsal side of this process at the bend, one or two minute spinules. Two conical processes in front of head.

NUMBER OF SEGMENTS AND PROCESSES OF ABDOMEN—Abdomen with eight segments and the tail-shovel possibly representing a ninth segment. In the middle of each lateral margin of first to eighth abdominal segments a lateral process, eight on each side, sixteen in all.

DORSAL ASPECT OF ABDOMEN—Seven pairs of spiracles, one pair on each of the first seven abdominal tergites; each spiracle being on the lateral area not far from the base of the corresponding lateral process. Spiracle on seventh abdominal tergite very small and flush with surface. Except on the first tergite, a strong spinule near each spiracle. The first tergite is altogether without spinules. On the second to seventh tergites the spinules are distributed as follows: On each tergite two sub-parallel trans-

verse series of spinules, one anterior and the other posterior. In the anterior series six widely-spaced spinules can be counted, although the extreme lateral ones (one on each side) are not in the same line but are placed much posteriorly and might almost equally well be regarded as belonging to the posterior series, which otherwise consists of four spinules slightly less widely spaced, the two inner ones opposite the central space of the anterior series. On the eighth tergite there are only two spinules in one transverse line.

VENTRAL ASPECT OF ABDOMEN—Each of the fourth, fifth and sixth ventrites has across the middle one transverse series of ten spinules, of which the median six are placed more closely and the two on each side not so closely and not in the same line but somewhat posteriorly. On the seventh ventrite the spinules have become irregular and somewhat smaller.

LATERAL PROCESSES—Short, each with two segments, a broad basal one and a smaller rounded one terminating in a point and fine hairs.

TAIL-SHOVEL—Different in structure from that of the larva. The prongs are smooth, enclosing an acute angle; each prong is broader at its base, tapering to a point at its apex and curving inward.

CHARACTERS COMMON TO ALL KNOWN LARVAE OF BRONTISPA

In conclusion, attention may be drawn to certain features common to all known larvae belonging to the genus *Brontispa:*

(1) The head is well-developed and not of the flattened type correlated with the leaf-mining habit in some hispine larvae.

(2) The pro-, meso- and metathorax are almost equal to one another in length and breadth and tend to lose the lateral marginal process, which is sometimes represented only by a tuft of fine hairs.

(3) The tail-shovel bears spines. The form and structure of the tail-shovel are specifically diagnostic; I believe that this is true not only for this genus but for the whole subfamily.

Food Preference of Protaetia fusca Grubs[1]

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PINEAPPLE RESEARCH INSTITUTE

(Presented at the meeting of December 12, 1949)

Information on the larval food preference of a newly discovered scarabaeid, *Protaetia fusca* (Herbst),[2] has been meager. Most members of the subfamily Cetoniinae to which the present species belongs are scavengers during their larval stage. An extremely dense concentration of grubs was observed in a pile of sugar mill mud press and leaf mold where this species was first discovered.[2] This fact was highly suggestive of its food preference. An experiment to determine the degree of preference was made under greenhouse conditions and its results are described in this note.

Two kinds of soil were used; one, with low trash content and the other, with high trash content. The former was a mixture of 87 per cent by volume of field soil with low humus content and 13 per cent of pulverized peat moss. The latter was a mixture of 33 per cent by volume of a similar field soil, 10 per cent of peat moss, and 57 per cent of partly decomposed leaf mold of monkey-pod tree and pineapple plant. These soils were placed in wooden boxes, each having about one-half cubic foot capacity. One young pineapple plant each was planted in half of the cages. Fifteen grubs of the late second instar were introduced into each cage after the roots had established themselves in the boxes. The four different treatments repeated in two cages per treatment were: (1) low trash soil with plant, (2) high trash soil with plant, (3) low trash soil without plant, and (4) high trash soil without plant.

The feeding period was limited to one month. Body weights of the grubs were determined with an analytic balance at the beginning and also at the termination of the test. Standard soil moisture sampling cans were used for confining the grubs individually while weighing. At the termination, carefully washed roots were examined for feeding injury under a lens of 10 times magnification.

Data are presented in Table 1. Normal survival and growth of grubs occurred in every cage of high trash soil, irrespective of plant growth in the cages. Two grubs only survived in the two cages of low trash soil with plant. They were both decidedly poorer in growth, and were found feeding upon the decaying basal leaves which were partly buried under the ground. Four grubs survived in the two cages of low trash soil without plant, but they were all starved and dying.

[1] Published with the approval of the Director as Technical Paper No. 191 of the Pineapple Research Institute, University of Hawaii.

[2] Pp. 9 and 20, this issue of "Proceedings."

Table 1.—Survival and body weight gain of Protaetia fusca larvae after a month's feeding in two kinds of soil with and without growing plant.

Treatment	Cage	Grubs Introduced	Grubs Survived	Average Body Weight at Beginning (gm)	Average Body Weight at Termination (gm)	Gain in Wt. (gm)
Low trash soil with plant	A	15	1	.1554	.4647	.3093
	B	15	1	.1610	.4239	.2629
High trash soil with plant	A	15	14	.1333	.7413	.6080
	B	15	13	.1428	.7587	.6159
Low trash soil without plant	A	15	3	.1352	.1310	—.0042
	B	15	1	.1330	.0950	—.0380
High trash soil without plant	A	15	15	.1506	.8023	.6517
	B	15	15	.1480	.7108	.5628

No feeding injury was found on the roots in any cage of either low or high trash soil. The indications were clear that the grubs specifically preferred to feed on trash and refused to feed on live roots in the absence of trash. Although the present demonstration was limited to pineapple roots, their preference for trash, however, will probably hold true even in the case of other plant species under ordinary conditions.

It is concluded that *Protaetia fusca* is a scavenger during its larval stage, showing specific preference for organic matter. Pineapple roots are not likely to be attacked by the grubs.

Studies on Oxyspirura mansoni, the Tropical Eyeworm of Poultry. IV. Methods for Control[1]

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(Presented at the meeting of December 12, 1949)

This paper, the fourth of a series, presents the results of a study made in Hawaii on the control of *Oxyspirura mansoni*, the tropical eyeworm of poultry, and of its intermediate host, the burrowing cockroach, *Pycnoscelus surinamensis* (Linn.). Previous papers in the series report on the biology of the host roach (Schwabe, 1949), the life history of the parasite (in press), and a preliminary study of its pathogenicity in domestic fowl (in press).

The life cycle of the eyeworm is such that it affords at least three vulnerable points for the institution of control measures: (1) the adult parasites may be removed from the eyes of the host by mechanical or chemical means, (2) the eyes may be rendered unsuitable for habitation by the parasites, or (3) control measures may be undertaken against the intermediate host. The feasibility of each of these methods was considered.

THERAPEUTIC TREATMENT

The adult parasites may be removed mechanically from beneath the nictitating membranes with a pair of dull tweezers. This operation is facilitated by anesthetizing the eye with either a 2 per cent cocaine or 5 per cent butyn solution. This at best is a slow, tedious process, however, which requires the services of at least two persons.

Wilcox and McClelland (1913) and Sanders (1928) suggested the following chemical treatment: Anesthetize the eye with butyn or cocaine, instill several drops of 5 per cent creolin solution, irrigate immediately with water to wash out the creolin and dead worms.

Fielding (1926) advices instillation of a few drops of turpentine, weak Condy's fluid ($KMn0_4$), or kerosene, which is allowed to remain in the eye one half hour, and then irrigation with lukewarm water or boric acid.

Although the above treatments are effective, they involve a considerable amount of labor per bird. Since the treated birds are susceptible to immediate reinfection, under most conditions of practical poultry husbandry these therapeutic measures would be economically unfeasible.

[1] Grateful acknowledgment is made to Yoshinori Tanada, Junior Entomologist, Hawaii Agricultural Experiment Station, for supplying the insecticides utilized, Dr. M. M. Rosenberg, Assistant Poultry Husbandman, H.A.E.S., for the experimental animals, and Harry Miyata, local poultryman, for his cooperation in this project.

PROPHYLACTIC TREATMENT

The life cycle of the eyeworm is such that, as far as is known, none of the common anthelmintics could be effectively utilized either prophylactically or therapeutically against the parasite.

Several years ago Hutson (unpublished manuscript) suggested surgical prophylaxis. He found that when the nictitating membranes were removed from uninfected chickens the conditions in the eyes were rendered unsuitable for subsequent habitation by the parasites. He also observed that when the membranes were removed from infected birds, the parasites were not present in the eyes after twenty-four hours.

Inasmuch as Fielding (1927) experimentally infected guinea pigs with the eyeworm, and I was successful in doing the same with rats (in press), neither of which possesses a nictitating membrane, I decided to undertake a similar experiment in an effort to corroborate Hutson's report.

I. Both eyes of a five-week old uninfected chicken were anesthetized with several drops of a 5 per cent butyn solution. The nictitating membranes were secured with hemostats and were removed with a pair of sharp scissors. Only slight hemorrhage developed and no further treatment was necessary. The bird experienced little discomfort during or after the operation, and in several days the eyes were completely healed. One week later approximately twenty infective larvae were introduced into the mouth of the bird by pipette. Examination of the eyes at necropsy, 48 hours after introduction of the larvae, revealed that neither nictitating membrane was completely removed and that larvae inhabited both eyes.

II. The right eyes of two uninfected chicks were nictitectomized, this time special care being taken to see that the membranes were completely removed. The left eyes were to serve as controls. The chicks were exposed to infection by feeding them each approximately ten infected roaches one week after the operation. At necropsy a week later the left eyes of both birds were found to be harboring many larvae, while a careful search of the right eyes revealed no larvae. Similar results were obtained upon repetition of this experiment.

This apparently verifies Hutson's observations. The following explanation is ventured. There was evidence of adhesions of the tissues of the right conjunctival sacs of both birds as a result of the nictitectomy. A possible mechanical block to the larvae may thereby have resulted from the operation. Increased lacrimation observed in the operated eyes after removal of the membranes supports this hypothesis. Although the chickens experienced no apparent ill effects following the nictitectomy this aspect should be investigated further before surgical prophylaxis is recommended.

CONTROL OF THE INSECT VECTOR

Effective control of *Pycnoscelus surinamensis,* the intermediate host, at present appears to be the most practical and economical approach to eyeworm prevention. Although several control measures for the Surinam roach have been advocated previously, the literature concerning its life history and biology is extremely scant. As a preliminary to this work a

brief study of the life history of the roach was undertaken (Schwabe, 1949). From this study it was evident that mechanical, chemical and biological control measures might be instituted against the roach. Each of these was considered.

MECHANICAL CONTROL OF THE ROACH

BATTERY HOUSING OF POULTRY:

In Hawaii, poultry is battery-raised on wire above the ground. This practice is made necessary by the shortage of available farming land and its high cost. Housing of chickens in this manner when properly done should serve as an effective mechanical barrier to the Surinam roach. I do not believe that the numbers of roaches which would reach the chickens by flying would present a problem. Each of the legs of the batteries should be set in a can of fuel oil, thereby preventing the roaches' access to the battery cages. This simple inexpensive method should prove a quite satisfactory control under most conditions.

SANITATION:

Through cleanliness and strict sanitation the roach population on the farm may be considerably reduced. The removal of accumulated manure, trash, and loose top soil from beneath the batteries destroys the habitat of the roaches. The effectiveness of this practice may be illustrated in the case of the University of Hawaii poultry farm. I made collections of roaches there in the fall of 1948. At that time manure was allowed to accumulate beneath the batteries. The roaches were numerous; a single trowel-full of soil would yield an average of thirty or more. Since that time the practice of frequent removal of the loose top soil and manure has been followed. In May, 1949, another collection of roaches was attempted there. At this time a fifteen minute search of the whole farm revealed only two adult roaches and one nymph.

The above practices of proper housing and strict sanitation are strongly recommended for eyeworm prevention.

BIOLOGICAL CONTROL OF THE ROACH

In Hawaii the natural enemies of the Surinam roach obviously fail to serve as an effective biological control.

PREDATORS:

The roach is eaten by several of the local birds, notably doves (*Streptopelia chinensis*), sparrows (*Passer domesticus*), and mynahs (*Acridotheres tristis*), all of which act as reservoir hosts of the eyeworm. In addition Illingworth (1941) found that *P. surinamensis* comprised from 40 per cent to 90 per cent of the diet of the introduced toad, *Bufo marinus*. These predators no doubt play an important yet indecisive role in reducing the numbers of the roach.

Ants are probably the chief insect enemy of the roach in Hawaii. On several occasions swarms of ants have been uncovered in the soil, which were attacking living roaches.

PARASITES:

In 1941 Williams successfully introduced into Hawaii from New Caledonia the bright green ampulicid wasp, *Ampulex compressa* F. This wasp is known to seek out and parasitize roaches of the genus *Periplaneta*. It has become well established here since its introduction.

Although I felt that the burrowing habits of the Surinam roach were such that it was not likely prey for the wasp, it seemed desirable to determine whether *Ampulex* would parasitize the roach under any circumstances. Through the courtesy of E. W. French, Graduate Assistant in Entomology, University of Hawaii, ten adult wasps were obtained. These were introduced into a large battery jar containing approximately twenty adult and nymphal forms of *P. surinamensis*. According to Williams (1942), *Ampulex* attacks its normal host immediately upon sight. The wasps were closely observed for several days, during which time they made no effort to parasitize the roaches. By the fourth day the wasps were all dead. The roaches were kept under observation for three weeks and then dissected. None showed any evidence of parasitism by the wasp.

Another group of four adult wasps was introduced into a large battery jar containing two adult *Periplaneta americana* and three adult *Pycnoscelus surinamensis*. Two of the wasps immediately attacked the American roaches, and although they were kept under observation for three days, they made no efforts to parasitize the Surinam roaches. These observations would indicate that this wasp does not parasitize *P. surinamensis*.

Hoffman (1927) reported 40 per cent parasitism of the Surinam roach by *Sarcophaga sternodontis* in the West Indies. At my suggestion C. E. Pemberton, Entomologist, Experiment Station, Hawaiian Sugar Planters' Association, a member of the Territorial Board of Agriculture and Forestry, secured authorization for the importation of this fly into Hawaii. R. H. Van Zwaluwenburg, Associate Entomologist, Experiment Station, Hawaiian Sugar Planters' Association, requested a shipment of the parasites from the University of Puerto Rico Agricultural Experiment Station. Entomologists at that station, in replying to the request, stated that Hoffman had been incorrect in his earlier observations. They reported that *Sarcophaga sternodontis* had been recovered only from dead roaches and many other dead insects, and was therefore considered saprozoic rather than parasitic. It has never been reared from a living insect as far as they were aware.

OTHER PARASITES AND COMMENSALS:

Below is a list of parasites and commensals which have been observed in or on the roaches dissected in the field and laboratory during the course of this study.

Protozoa—Numerous cephaline gregarines (not identified), occurring singly and in syzygy in the digestive tract. (These were found even in the new-born nymphs).

A small flagellate and a large ciliate (not identified) were common in the digestive tract and Malpighian tubules.

Helminths—Other than the eyeworm, no helminth parasites were found.

Insecta—No evidence of parasitism by insects was noted.

Acarina—The mite shown in figures 2 and 3 commonly attacked the roach both in the laboratory and its natural habitat. A number of laboratory-housed roaches apparently died from infestation with these mites.

No other reports of parasites of the Surinam roach have been discovered in the literature during the course of this study. Until such reports are forthcoming, prospects for the biological control of *P. surinamensis* are not encouraging.

CHEMICAL CONTROL OF THE ROACH

Alicata (1938) reported the effectiveness of butyric fermentation baits in trapping the roaches, but methods such as this would prove impractical under normal farming conditions.

Carbon bisulphide and Diesel oil have also been employed with varying degrees of effectiveness.

In 1947-48 Kartman, Tanada, Holdaway, and Alicata (1949) undertook an investigation on the chemical control of arthropod vectors of poultry parasites. Of the insecticides compared in these preliminary tests, they found parathion to be most effective against the roach, achieving a kill of 95 per cent in 24 hours, under the conditions of the experiment. Chlordane with a kill of 70 per cent, D.D.T. in kerosene with a kill of 75 per cent, and benzene hexachloride, gamma isomer, with a kill of 65 per cent, also showed promise.

Although extensive field trials of these insecticides are indicated, preliminary trials show that weekly dusting with 1 per cent benzene hexachloride, or better, spraying with 1 per cent chlordane and/or 1 per cent D.D.T. in kerosene, would materially reduce the roach population on the farm. If frequent removal of the manure were also undertaken, virtual eradication of the roach population should be the result. This treatment would probably control most of the other manure-inhabiting insects as well. This author cannot recommend the use of parathion by the inexperienced farmer or technician because of its extreme toxicity to warm-blooded animals.

SURVIVAL OF EYEWORM LARVAE

The Poultry Husbandry and Entomology Departments of the Hawaii Agricultural Experiment Station recently undertook a joint project to determine whether floor-brooding of chicks, a heretofore impractical method in Hawaii, would be possible through effective chemical control

of the Surinam roach (unpublished work). The prospect that chicks might still have access to dead roaches even under such conditions of chemical control suggested the following problem.

It seemed desirable to ascertain whether or not the infective eyeworm larvae were capable of surviving any appreciable length of time in roaches which had died or had been killed by various means. Sanders (1928) killed several roaches (he did not state how), placed them in a moist chamber, and found that after 48 hours the roaches still contained active third-stage larvae. I decided to repeat Sanders' experiment as a starting point. Several adult roaches were decapitated and placed in a vial containing moist cotton. At the end of 48 hours the roaches were torn apart and placed in a water bath heated to a temperature of approximately 37° C. Numerous active infective larvae were shed. Since such favorable conditions of humidity are not apt to be encountered under natural circumstances, I modified the foregoing experiment as follows: several decapitated adult roaches were placed in an open container in the laboratory where they would be subject to the natural conditions of drying and decomposition. Roaches were removed at the following intervals of time as shown in Table 1 and checked for viable infective larvae.

Table 1.—Survival of Infective Larvae in Roaches Killed by Decapitation

Time	Results	Time	Results
15 min.	Viable larvae shed	24 hours	Viable larvae shed
30 min.	Viable larvae shed	48 hours	Viable larvae shed
1 hour	Viable larvae shed	72 hours	Viable larvae shed
2 hours	Viable larvae shed	96 hours	Viable larvae shed
5 hours	Viable larvae shed	108 hours	Larvae dead

Having shown that third-stage larvae were capable of surviving in the body of a dead roach over an appreciable length of time under normal meteorological conditions, it seemed advisable to determine whether the larvae survived equally well in roaches killed with a variety of the common commercial insecticides.

Roaches were killed with chlordane, benzene hexachloride, sodium fluoride, parathion, and lethane by permitting them to walk over a glass surface treated with the material being tested (Schwabe, 1950). They were then placed in open containers exposed to normal atmospheric conditions and examined for viable larvae at periodic intervals. The results of these tests are shown in Table 2.

In the control roaches, death of the larvae apparently resulted from insufficient moisture and/or increased osmotic concentration. In all instances death of the larvae was hastened through exposure to the insecticides. The significant information obtained however was the fact that roaches killed with a variety of commercial insecticides serve as effective vectors for Manson's eyeworm as long as 72 hours after death.

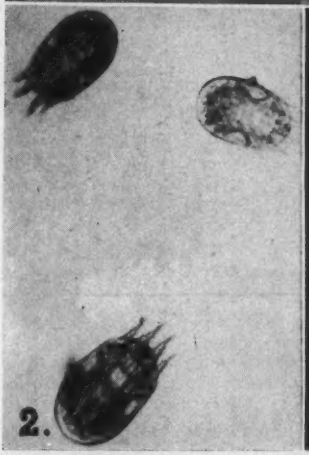

Figure 1.—The type of poultry housing and sanitary surroundings which are strongly recommended for the effective control of eyeworm infestations in domestic fowl. The legs of the batteries should preferably stand in cans of fuel oil.

Figure 2.—An unidentified mite commonly found infesting the Surinam roach, both in the laboratory and in its natural habitat.

Figure 3.—An adult *Pycnoscelus surinamensis* infested with the mites shown in Figure 2.

Table 2.—Viability of Infective Larvae—Survival when Subjected to Commercial Insecticides.

6/14 to 6/20 1949	Chlordane 2% Petroleum Solvent	Chlordane Tech. 43% Pet. sol. 47% Inert 10%	Hexachloro-cyclohexane 50% powder Inert 50%	NaF 100% dust	Parathion 15% Wettable Powder	Lethane 10% powder Inert 90%	Control Killed by Crushing the Head
12 hours.....	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed
24 hours.....	Viable larvae shed	Larvae dead	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed
36 hours.....	Larvae dead	Larvae dead	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed
48 hours.....	Larvae dead	Larvae dead	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed	Viable larvae shed
60 hours.....	Larvae dead	Larvae dead	Viable larvae shed	Larvae dead	Larvae dead	Viable larvae shed	Viable larvae shed
72 hours.....	Larvae dead	Larvae dead	Larvae dead	Larvae dead	Larvae dead	Viable larvae shed	Viable larvae shed
84 hours.....	Larvae dead	Larvae dead	Larvae dead	Larvae dead	Larvae dead	Larvae dead	Viable larvae shed

SUMMARY

The various therapeutic treatments which have been proposed for eyeworm infections in poultry are discussed and evaluated. For practical control they are not recommended since the chickens are susceptible to immediate reinfection following the treatment.

A method of surgical prophylaxis proposed by Hutson is discussed in light of experiments performed by the author, but this method is not recommended at present.

Consideration is given to various methods for the mechanical and chemical control of *Pycnoscelus surinamensis*, the intermediate host of the eyeworm. Proper housing of chickens, strict sanitation, and use of certain of the recently tested insecticides is strongly advocated by the author as the most practical and effective means for the control of the eyeworm.

The present outlook on the possibilities for biological control of the roach in Hawaii is also discussed, and data on the survival of eyeworm larvae in roaches killed by mechanical and chemical means are presented.

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Morganella longispina (Morgan) on Avocado in Hawaii (Homoptera: Diaspididae)

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(Presented at the meeting of January 10, 1949)

When the annual shedding of leaves from my avocado tree at 2044 Lanihuli Drive, Manoa Valley, commenced, I first noticed, December 14, 1948, on fallen leaves, small black scales which I had never seen before. The scales were quite numerous on the under side of the leaves, and located along the sides of the midrib and other veins. On further examination nearly every leaf on the ground was found to have the scales, and many of those on the lower branches had the scales also. The infested leaves were readily distinguished by yellowing spots showing on the upper surface, caused by the presence of the scales beneath.

On search in the neighborhood, December 16, fallen avocado leaves with a few of the scales were found in several nearby locations: Lipioma near Beckwith, Mohala Way near Beckwith and Linohau Way near its eastern end. Then on December 26, I found fallen kukui leaves with the scales on the underside at base in the axils of the veins.

C. E. Pemberton made slide mounts and determined the species to be *Morganella longispina* (Morgan), by comparing with the figure of the species in "Insects of Hawaii," 5:358, 1948, and in Ferris's "Atlas of American Coccidae", S. II:244, 1938. Mr. Zimmerman sent material to H. L. McKenzie at Sacramento, California, who also determined it as *Morganella longispina.*

Apparently the present sudden appearance of this scale on avocado leaves is significant as the first record of its occurrence on this hostplant, and the first record of it on leaves, as other records have been of its occurrence on bark. It is strange also that this scale has apparently escaped notice by the entomologists in Hawaii for over 30 years, since the Kotinsky records on fig and Bombay mango in 1906 (Proc. Hawn. Ent. Soc. 1:78, 1906 and Report of Hawaii Experiment Station for 1912, page 38).

The early history of the occurrence of *Morganella longispina* in Hawaii is revealed in a field note (No. 1122) of Albert Koebele, which records his finding it in Kona, Hawaii, in February 1894: "a small black scale on the bark of mango, kukui and other trees"; and in July, 1896, he found it at Lihue, Kauai, "very abundant and destructive to fig and orange trees in a garden". Then, again from the Kona locality, September, 1896, Koebele reared parasites from this scale which were described by Dr. Howard from Koebele's slide mount No. 1122 as *Prospaltella koebelei* (Ann. Ent. Soc. Amer., 1:282, 1908). When first found by Koebele, specimens of the scales were transmitted to Maskell, who determined them as *Aspidiotus longispina* Morgan, which was the name used in Koebele's note No. 1122 (Trans. N. Z. Institute, 27:38, 1895). Kirkaldy's record of *Aspidiotus*

maskelli Ckll. in Fauna Hawaiiensis 3:107, is apparently from the same Koebele material.

Pteroptrichoides perkinsi Fullaway is another parasite reared from *Morganella longispina*, described in Report of the Hawaii Experiment Station for 1912, page 28, as having been "Bred from a coccid (n.g. and n. sp.) on Bombay mango by Jacob Kotinsky, August 24, 1906, Honolulu". In a later list of scale parasites (Proc. Hawn. Ent. Soc., 4:245, 1920), Fullaway gives *Morganella longispina* as the host of this parasite. Timberlake in Proc. Hawn. Ent. Soc., 5:438, 1924, assigns the parasite *perkinsi* to the genus *Archenomus*, and refers to the same record by Kotinsky as above: August 24, 1906.

Apparently there were no more records of *Morganella longispina* in Hawaii since the Kotinsky record of 1906, which was no doubt on a mango tree in Moanalua Gardens where Mr. Samuel Damon was growing several Indian varieties of mangoes, among them the Bombay mango.

This heavy infestation on my avocado tree indicates the probability that this scale may be more generally present than we were conscious of, and can be found if searched for. I have reared two different parasites from the scales found on kukui leaves, but they are not the same parasites mentioned above: *Comperiella bifasciata* Howard and *Aphytis chrysomphali* (Mercet). (Later, these parasites were reared from *longispina* on avocado leaves.)

Later records of the distribution of *Morganella longispina*:

During the year 1949 this scale was found at various times in the following places:

March 13—On fallen kukui leaves in the small park in fork of Manoa Road and East Manoa Road, and they were thus found at all times throughout the year.

April 10—On kukui leaves near east end of Nehoa St.

April 10—On leaves of *Bauhinia purpurea* on Ualakaa St. The scales were situated on underside in axils of veins at base, the same as on kukui leaves.

April 24—On kukui leaves on Ferdinand St., and on Manoa Road at the Waioli tea room.

July 24—On kukui leaves on Nehoa St., west of Keeaumoku St.

August 14—At 2044 Lanihuli Drive, an occasional scale on avocado leaves on the tree, and also on twigs at leaf scars and other rough places. This indicates how this scale can survive the annual complete shedding of leaves before blooming time.

October 16—On kukui leaves at McKinley High School.

October 19—On kukui leaves in several places in upper part of Woodlawn, Manoa Valley.

October 19—On a yellow fallen leaf of avocado there were green spots showing on upper surface where there were scales on lower surface.

November 27—On kukui leaves, Kaneohe, on road below the Pali.

December 4—On kukui leaves, Makiki Valley at waterworks park.

December 12—Abundant on fallen avocado leaves at 2044 Lanihuli Drive, the same as they were the previous year.

January 1, 1950—On kukui leaves in Kalihi Valley.

Notes on the Life Cycle of certain Introduced Cerambycid Beetles

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(Presented at the meeting of March 14, 1949)

It is known that many of the cerambycid beetles spend considerable time in the larval stage. Little is definitely known about the length of the life cycle of the endemic species of cerambycids in Hawaii, or of the dozen or so introduced species. I have lately made some observations which demonstrate that some of the introduced species have a surprisingly short life cycle.

About the middle of October, 1948, some living healthy branches were pruned from my large breadfruit tree. Some of these were left standing beneath the trees, by the boundary fence. Unfortunately, as it turns out, close observations were neglected, and never were any adult cerambycids observed attracted to these branches. It may be that they are entirely nocturnal and only visited the branches at night time for oviposition. I have often seen the beetles coming to the window screens at lights, which indicates that they have nocturnal activities. Be that as it may, late in December there was evidence that the branches were infested with larvae as shown by extrusions of frass from the bark. At this time a 4-foot branch about two inches in diameter was sawed into foot lengths and placed in a large battery jar for further observation.

On January 5, 1949, scolytids began to issue. There were four species, and the number that issued by the time they had finished at the end of the month were as follows:

9 **Xyleborus fornicatus** Eich.
88 **Ericryphalus sylvicola** (Perkins)
13 **Ericryphalus** sp.
1 **Crossotarsus externedentatus** Fairmaire

It is apparent that their life cycle is not more than two or three months.

Cerambycid beetles were later in issuing, and were of four common species. They were as follows, with their issuing periods:

20 **Lagocheirus obsoletus** Thomson, January 28 to March 6.
28 **Oopsis nutator** (Fabricius), February 1 to March 3.
16 **Pterolophia camura** Newman, February 7 to March 3.
13 **Sybra alternans** Wiedemann, February 11 to February 27.

Thus it is shown that the life cycle of these four cerambycids is rather short, even for the largest one, *Lagocheirus obsoletus*. The majority of the beetles issued during February, which would make their life cycle not

more than four months. The larval period would of necessity be determined by the condition of food supply. Their habit being to feed on the inner fermenting and decaying bark and the outer wood, they must obtain their growth before these food materials become too much dried up. This is a different matter than with those cerambycids whose larvae feed in living wood. The larvae of these four species eventually bore into the wood to form pupal cells for final transformation, but I am not certain whether in this boring of the wood any is actually consumed. At any rate, they depend chiefly on the outer wood and inner bark for making their main growth, and doing this before these materials become too much dried up.

During the above observations single specimens issued of the following beetles, indicating for them also a short life cycle:

Oxydema fusiforme Wollaston
Dryophthorus distinguendus Perkins
Exillis lepidus Jordan

Contribution to the Study of Hepialidae (9th Note):[1] The Genus Phassodes Bethune-Baker (Lepidoptera)

By PIERRE E. L. VIETTE

DEPARTMENT OF ENTOMOLOGY
MUSEUM NATIONAL D'HISTOIRE NATURELLE, PARIS

(Presented by Mr. Van Zwaluwenburg at the meeting of May 9, 1949)

The genus *Phassodes* was described by Bethune-Baker in 1906 (Pr. Zool. Soc. London, p. 89) for six species from the Fiji Islands. Earlier, Rothschild (Novit. Zool., 2:482, 1895) had described a species from Fiji, *vitiensis*, which he placed in the genus *Leto* Hübner. Later, Tams (Ins. of Samoa, 3, Lepidoptera, fasc. 4:289, 1935) refers specimens collected by Buxton and Hopkins to *Phassodes vitiensis* (Rothschild), indicating that Rothschild's species does not belong in *Leto*.

Through the kindness of Mr. Riley and Mr. Tams, we have been able to see in the British Museum (Natural History) the specimens cited in the literature. Here follow a few remarks based on the examination of that material.

In the first place *Phassodes nausori* Bethune-Baker is a synonym of *P. vitiensis* (Rothschild). Then, in spite of the signs "♂" placed by Bethune-Baker before each of his descriptions, only his *Phassodes odore-valvula* is a male; the other descriptions are based on females. It is likely that these descriptions are those of females belonging to a very variable species, but we have not sufficient material to synonymize any of Bethune-Baker's names, except *P. nausori*.

The genus *Phassodes* is valid, and we shall complete here Bethune-Baker's original diagnosis by a description of the male genitalia and a few words on the scent gland.

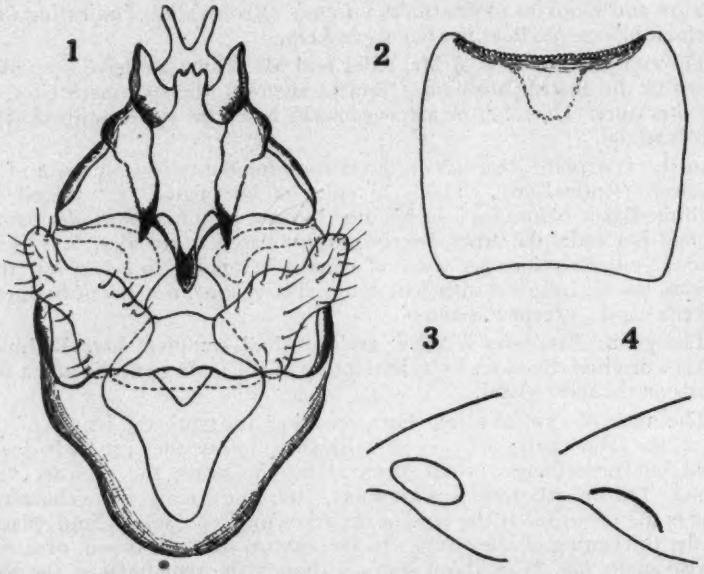
The antennae are filiform, short, reaching one-tenth the length of the costa; the labial palpi are porrect, with three joints, they are little developed but nevertheless visible from above the head; the eyes are very broad. The metathoracic legs are short. But, in the male, more characteristic is the presence, at the base of the forewings, of a scent gland, placed in the thickening of the wing. On the ventral side is a broad, oval, yellowish plate (fig. 3), without scales, although the remainder of the base of the wing is covered with them. On the dorsal side, the gland is open in a bow-shaped slit (fig. 4) through which is seen an area abundantly covered with very slender, short and blackish hairs. This area corresponds to the yellowish plate on the ventral side. Between the slit and the Sc, the base of the wing is strongly swollen. This case is interesting because it is the only one known to exist in the Hepialidae, and is unrecorded in the literature, in spite of a brief allusion to it by a line in Bethune-

[1] Seventh note: Bull. Soc. Ent. France, 1949, pp. 72-73. Eighth note: Bull. Soc. Zool. France, 74: 47-49, 1949.

Baker's description. In the Hepialidae the scent glands are usually on the metathoracic tibiae, generally in the shape of long, specialized hairs (for example, *Hepialus humuli* L., *Charagia daphnandrae* Lucas, *Phassus trojesa* Schaus), but sometimes altering the whole shape of the tibiae (*Hepialus hectus* L.).

Male genitalia. The eighth sternite is in the shape of a subrectangular plate, with the caudal edge better sclerotized, and with pads (fig. 2). The dorsal parts of the genitalia (fig. 1) have two points that may represent an uncus; the processes of the tegumen are well developed, pointed at their apex, the whole of the apical parts being bounded to a medial plate in the form of a gutter; this structure is connected with the suspensorium; the juxta is subtriangular; the valves are upturned, broad at their bases and suddenly narrowed at their distal third.

The genus is known now only from Fiji and Samoa, but serious research might show that it exists in other islands of the South Pacific.



Phassodes odorevalvula Bethune-Baker. **Fig. 1,** male genitalia; **fig. 2,** 8th sternite of male; **fig. 3,** base of anterior wing, male (ventral side); **fig. 4,** same, dorsal side (showing scent gland).

A new Genus and Species of Elachistidae Mining Lonicera Leaves in Hawaii (Lepidoptera)

By ELWOOD C. ZIMMERMAN

EXPERIMENT STATION, H.S.P.A.

and J. D. BRADLEY

BRITISH MUSEUM (NATURAL HISTORY)

(Presented at the meeting of December 12, 1949)

In July 1949 a microlepidopterous leafminer which proved to be new to the Hawaiian fauna, was discovered by C. E. Pemberton in the leaves of Japanese honeysuckle, *Lonicera japonica*, which were brought in by Miss Wilhelmina Tenney from her residence at Makiki Heights, Honolulu. Dr. O. H. Swezey traced it to the family Elachistidae but literature was not available to go further with its identity, and it was sent to us at the British Museum (Natural History) for study. We have concluded that the moth represents not only a new species, but also a new genus. It is a foreign insect which has accidentally been introduced into Hawaii, but we can supply no information as to its original home. Nothing like it is in the British Museum, and J. F. G. Clarke reports that it is not represented in the U. S. National Museum. In a paper following this report, Dr. Swezey discusses the interesting habits and life history of the new moth.

Swezeyula, new genus

Head short, smooth-scaled, but with erectile hair-scales beneath the broad, smooth scales, and when the hair-scales are erected they displace the broad scales and the head appears very rough and quite different than when in repose; proboscis reduced, slightly shorter than labial palpi, scaled only at base; labial palpi slender, porrect or drooping, twice as long as vertical diameter of an eye, apical segment slender, awl-shaped, pointed, two-thirds to nearly as long as penultimate segment (measured on specimen); antenna a little more than one-half length of forewing, scape with a dense basal pecten of many, stiff hair-like scales, antennal insertion contiguous to upper margin of eye.

Forewing ovate-lanceolate, about four times as long as broad (excluding fringes); 1a absent, 1b forked at base, 1c present, 5 absent, 6 out of 7 at about middle, 7 to costa, 8 absent, 11 terminating on costa opposite a point between origins of 10 and 9 on genotype, medial stem faintly indicated in cell.

Hindwing at its broadest part (excluding fringes) about one-half breadth of forewing, narrowly lanceolate, costal margin slightly concave beyond middle, posterior margin convex; 1a, 1b, 1c present, but these may be weak or incomplete, 5 absent, 6 out of 7 at about middle, medial stem

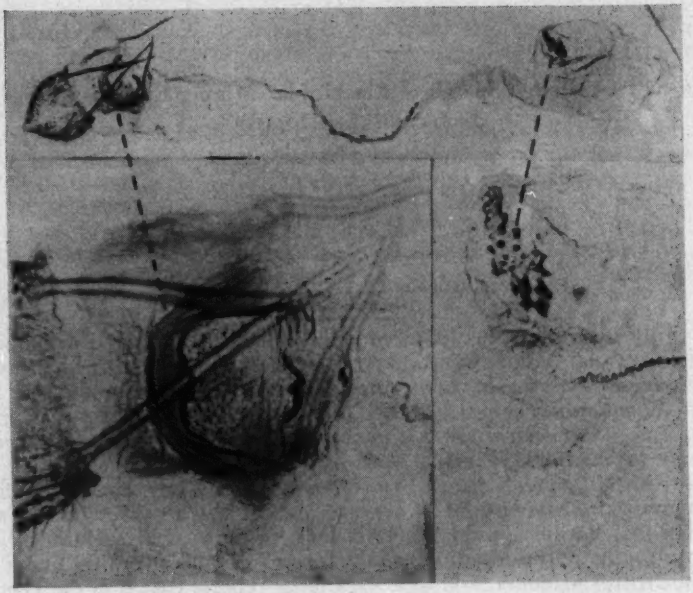


Figure 2.

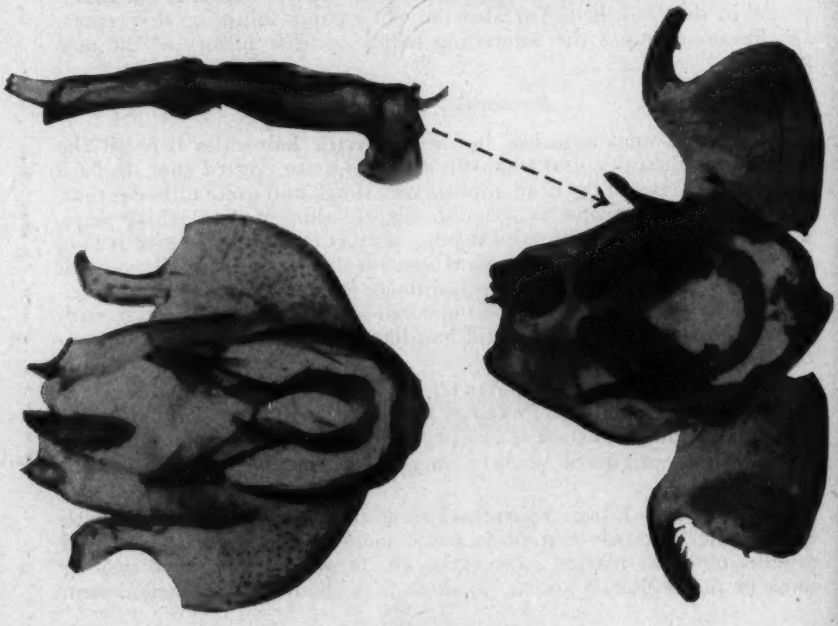


Figure 1.

close to 7, faintly indicated in apical part of cell which is closed; longest fringes two and one-half times as long as greatest breadth of hindwing.

Thorax and abdomen smooth-scaled, without tufts.

Posterior tibiae with long hairs on both dorsal and ventral edges; first pair of spurs arising at between one-fourth and one-third from base, outer spur only about one-half length of inner spur on genotype.

Male genitalia: uncus absent; socii reduced; gnathos a subcircular, spinulose knob; valvae broad, dorsal apex of each produced as a finger-like process; sacculus present; lobes of anellus strongly developed in form of finger-like processes; aedeagus with manica, without cornuti.

Female genitalia: genital plate well defined, more or less horseshoe-shaped, with arms directed cephalad; ovipositor lobes broad; ductus bursa long, slender; bursa copulatrix subspherical, signum transverse, denticulate in genotype.

Genotype: *Swezeyula lonicerae*, new species.

Swezeyula appears to be a close ally of *Perittia* Stainton, 1854, a genus now containing several species recorded from Europe, Algeria and the Canary Islands. It is probable, however, that only the genotype belongs to the genus. Examination of *Perittia cedronellae* Walsingham, *lavandulae* Walsingham, and *calpella* Walsingham, 1908, from the Canary Islands and Gibraltar, shows that they belong to a different, probably new, genus. Further study of the group is necessary. The genotype, and only species occurring in England, *Perittia oleae* (Haworth, 1828) (= *oleella* Stephens, 1834, and *obscuripunctella* Stainton, 1848) also feeds on *Lonicera*. In the forewing of *Swezeyula* vein 6 arises from about the middle of 7, but in *Perittia* its origin is much nearer the base of 7. The proboscis of *Perittia* is longer than the labial palpi, and it is thick and squamose for a distance greater than the length of the palpi, but on *Swezeyula* it is shorter than the palpi and squamose only at extreme base. The antennae of *Perittia* are inserted at a distance above the eyes (a bare space is distinctly defined between the eye and antenna), but on *Swezeyula* the antennal insertions are contiguous to the eyes. *Perittia* does not have the erectile hair-scales on the head which are present on *Swezeyula*. The illustrations (Figs. 1 and 2) show the characteristics of the genitalia of *Perittia* and *Swezeyula*.

From a brief investigation of the *Perittia* group of genera, it is apparent that the section is in need of critical study and revision. As noted above, the Canary Island species now in the genus must be removed. Another genus examined was *Scirtopoda* Wocke, 1876 (genotype *herrichiella* Herrich-Schaeffer), and it was found that the included species *saltratricella* Fischer von Roslerstamm (as determined in the British Museum) not only is not a *Scirtopoda*, but it belongs to the family Heliozelidae—not

Figure 1.

Figure 1.—Features of male genitalia. Top left, *Perittia oleae* (Haworth), from Dorset, England, 0.55 mm. across. Top right, aedeagus of *Swezeyula lonicerae*, new species, length 0.55 mm. Bottom, *Swezeyula lonicerae*, new species, 0.8 mm. from tip to tip.

Figure 2.—Details of female genitalia of *Swezeyula lonicerae*. Entire genitalia (overall length 2 mm.) on right, with enlargements of genital plate and signum on left.

Elachistidae where it now stands. *Scirtopoda* is also closely allied to *Perittia* and *Swezeyula,* but may be separated (in genotype) by veins 3-4 in hindwing being connate. From the literature it appeared that *Perittia* and *Onceroptilia* Braun, 1948, were synonymous, but J. F. Gates Clarke has compared material at the U. S. National Museum for us, and states that in his opinion the names belong to two allied but distinct genera.

It gives us much pleasure to dedicate this new genus to Dr. O. H. Swezey, who has done so much to advance our knowledge of the Hawaiian Lepidoptera.

Swezeyula lonicerae, new species (Figs. 3, 4 and 5)

A gray-appearing species with two small but outstanding dark spots on forewings.

Head basically with cream, or grayish cream-colored scales intermixed with fuscous scales, some of the cream scales are tipped with fuscous. Antenna with scape colored as head; segments to about middle alternating pale and dark, but the contrast not great, gray beyond middle; scales prostrate to about middle, thence usually slanting erect to apex and giving a roughed-up appearance to apical half in both sexes, but usually more pronounced in male. Labial palpus with creamy white ground color, often with grayish cast, inner side paler, outer side with more scales fuscous-tipped and usually conspicuously darker than inner side.

Pronotum and tegulae colored as head, or more grayish fuscous. Legs mostly dark fuscous flecked, or intermixed, with cream-colored scales on outer sides and pale cream on inner sides, but hind legs with less dark color than middle and fore pairs, femora on some examples mostly pale, tarsal segments pale-tipped; long hairs of hind legs pale, similar to fringe of hind wings; [fore leg—femur, 21, tibia, 17.5 (spurs subequal in length, 6 units long, inserted at distal third), first tarsal segment 16, remainder of tarsus 15; middle leg—femur 25, tibia 28 (spurs inserted at apex, inner one 14, outer one 12), first tarsal segment 18, remainder of tarsus 19; hind leg—femur 28, tibia 48 (upper pair of spurs inserted just basad of basal third, outer spur 14, inner spur 27; outer apical spur 12, inner apical spur 16), first tarsal segment 23, remainder of tarsus].

Forewings almost uniformly clothed above with grayish cream-colored, fuscous-tipped scales, the gray-fuscous color predominating and giving the insect a gray appearance under low magnification, the pale and dark scales giving a characteristic flecked, or "salt and pepper" appearance to entire wing, but with a small, dark, fuscous or black spot just basad of middle of wing on plical fold and a similar spot at apex of cell; hindwings only slightly paler than forewings, cilia uniformly dark gray; undersides of wings much as upper sides, but without the two dark spots on forewings.

Abdominal scales cream, grayish and fuscous, without maculae; paler cream beneath, more fuscous on dorsum.

Male genitalia: socii reduced to low, rounded, pilose papillae; gnathos almost round as seen from behind or beneath, barbed with short, strong spines; valva broad, short, with dorsal apex much produced and curved ventrad, deeply excavate beneath, thus giving apex a curved, finger-like shape, apical area setose; sacculus with about its apical half produced as a free, triangular flap, inner side of flap and opposite area of valva, setose; sides of tegumen broad, tapering to socii; anellus produced at each side into a heavily sclerotized, elongated prong which is broad basad, tapering to about middle, thence produced as a long, slender, finger-like process; juxta a transversely elongated, narrow plate; vinculum unevenly rounded, very broadly triangular ventrad, only slightly thickened medio-ventrally; aedeagus five times as long as breadth of extreme base, but ten times as long as subapical breadth, cylindrical, slightly arcuate, sinuate; transtilla membranous.

Female genitalia: ostium small, funnel-like; genital plate strongly sclerotized, inner edge slightly triangularly produced cephalad at middle; ovipositor lobes broad, tapering abruptly to a shortly-produced point, clothed with numerous long hairs; apophyses very slender, tapering to fine points, anterior pair about three-fourths as long as posterior pair, posterior pair slightly longer than ovipositor lobes (measure ovipositor lobes on chord from origin of apophyses to apex), anterior apophyses each originating

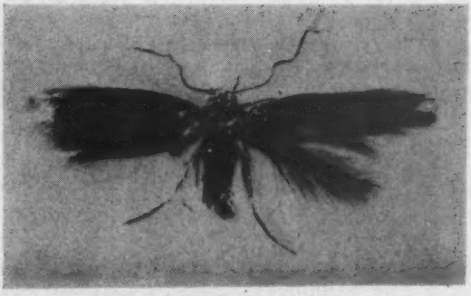


Figure 3.—Adult of *Swezeyula lonicerae;* expanse 8.5 mm.

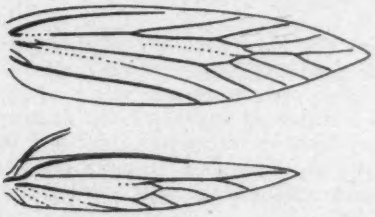


Figure 4.—*Swezeyula lonicerae,* venation of fore and hind wings.

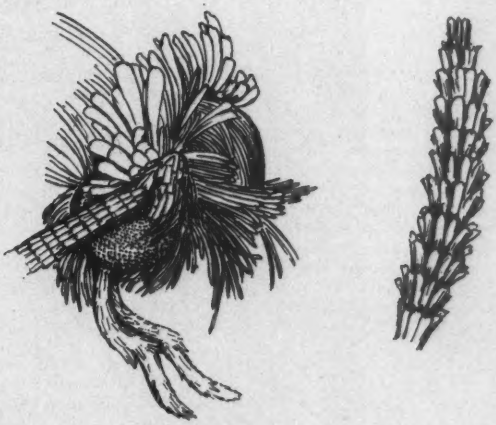


Figure 5.—*Swezeyula lonicerae.* **Left,** lateral aspect of head with scales erected; **right,** apical antennal segments showing rough scaling.

from the outer corners of a dorsal plate which is not as heavily sclerotized as genital plate, this plate-like area transverse, not quite twice as broad as long, and subequal in length to an anterior apophysis.

Expanse of forewings: 8 to 9 mm.

Holotype male, allotype female and a series of paratypes, reared from mines in the leaves of *Lonicera japonica* from Honolulu, Hawaii, by O. H. Swezey and J. S. Rosa, September through December 1949. The holotype and allotype will be deposited in the U. S. National Museum, and paratypes will be placed in the collections of the Experiment Station Hawaiian Sugar Planters' Association and the British Museum (Natural History).

Notes on the Occurrence and Life History of the Honeysuckle Leafminer, Swezeyula lonicerae, in Hawaii.

By OTTO H. SWEZEY

CONSULTING ENTOMOLOGIST, EXPERIMENT STATION, H.S.P.A.

(Presented at the meeting of December 12, 1949)

This recent immigrant elachistid moth was first brought to the attention of the entomologists when, in July, 1949, Miss Wilhelmina Tenney brought in branches of the Japanese honeysuckle, *Lonicera japonica*, from her grounds on Makiki Heights, Honolulu, with many dried leaves which Mr. C. E. Pemberton found to be due to a leafminer. Larvae were found in some of the leaf mines, and one moth was reared, issuing August 7. Also, one parasite, *Notanisomorphomyia externa* Timberlake, issued from a mine July 11.

As the moth was so entirely different from any known species of the many lepidopterous leafminers occurring on various native plants, it was at once considered to be a new immigrant pest, and search was made for its possible occurrence in other parts of Honolulu. The host-plant was found to be planted in private and public grounds in many parts of the city. In some of these plantings no evidence of leafminers was found, but in other regions infested leaves were found, often quite abundant.

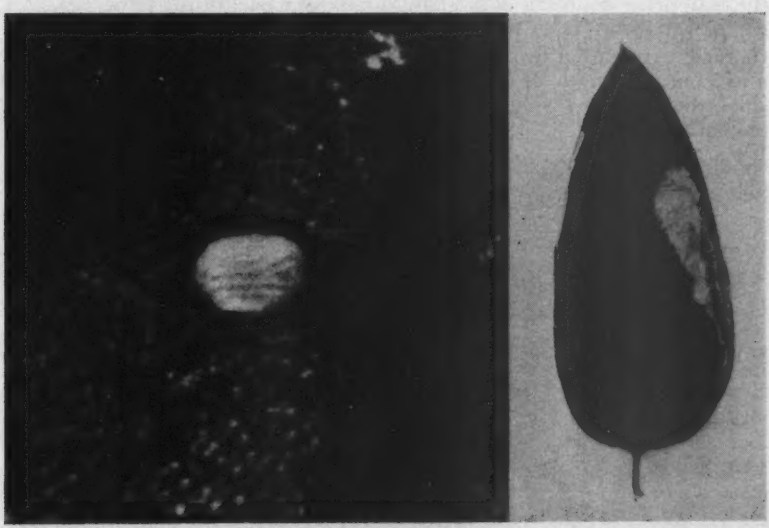


Figure 1.—Left, egg (greatly enlarged). **Right,** mine in honeysuckle leaf.

On August 23, J. S. Rosa obtained abundant material from the waterworks park on upper part of Makiki Street, and more moths were reared. He also reared two specimens of *Zagrammosoma flavolineata* Crawford from this material, which is the first record of its occurrence in Hawaii. Later, Mr. Rosa found this leafminer in honeysuckle in upper part of Nuuanu Valley, and in Pacific Heights, and he and R. H. Van Zwaluwenburg found it up in Kalihi Valley.

October 19, mines were found common by the writer on a patch of honeysuckle vines in the upper part of Woodlawn, in Manoa Valley. Moths were reared, issuing November 9 to 13. November 9, the writer found mined leaves on honeysuckle by the roadside at 2466 Manoa Road, Manoa Valley. Moths were reared, December 4 to 19. One parasite also was reared, *Pseudopheliminus vagans* Timberlake. Then on November 13, a few old mines were found in honeysuckle leaves on the campus of the University of Hawaii in Manoa Valley, but there were no mines containing larvae. On December 4, the writer collected a good number of mines having full-grown larvae, from honeysuckle at the waterworks park in Makiki Valley. Cocoons were formed December 5 to 9 and the moths issued December 25 to 29. This is the extent of distribution of the moth so far as known at present.

There is usually but one mine per leaf, but occasionally a leaf is found with two mines. The mine starts from the place where the egg is laid on the upper surface of the leaf near the margin. The mine is slender, following the margin for some distance, gradually enlarging, and finally producing considerable of a blotch by widening towards the middle of the leaf, often doubling back along the slender part of the mine.

The full-grown larva has a reddish tint. The head is dark and the first thoracic segment has two dorsal wide dark longitudinal bands. It is about 4 to 5 mm. in length, of nearly even width, segmentally crenate along the sides, the thoracic segments only slightly wider. There are four pairs of abdominal prolegs.

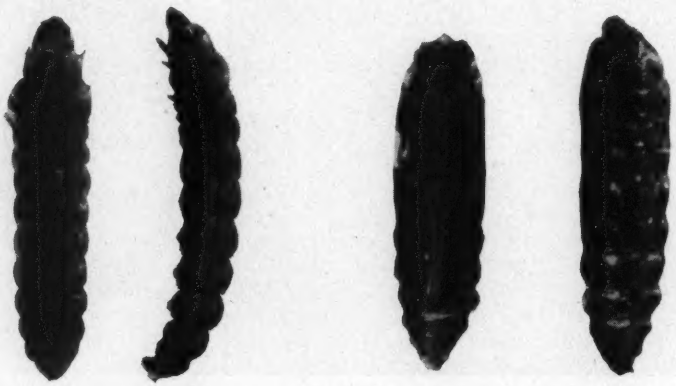


Figure 2.—Left, larva, dorsal and lateral views. **Right,** pupa, ventral and dorsal views.

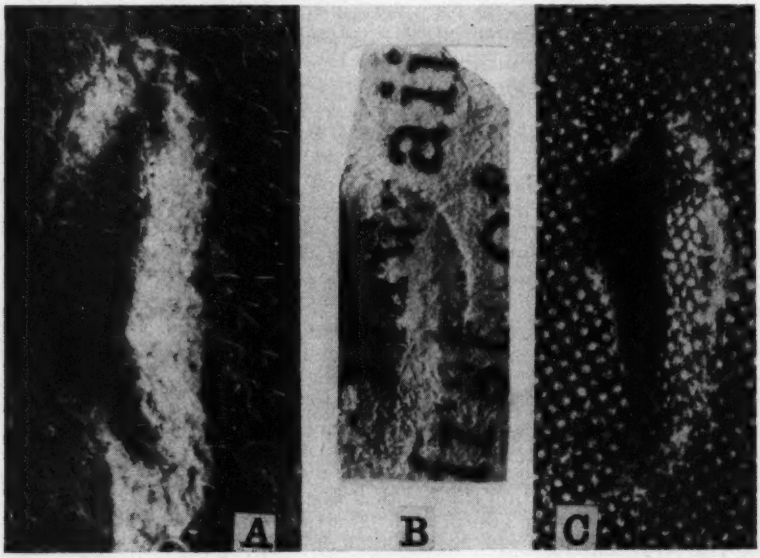
The larva issues from the mine and the cocoon is made on the surface of the leaf or some other object. However, this is not really true, as ascertained by the following observations: The first cocoons that were observed were constructed on leaves in the tin salve box used as a cage. But in another tin box having bits of paper among the leaves, the cocoons were made by preference on the paper. One piece of paper having printing on it was noticed to have the printing on the upper surface of the cocoon without the position of the letters being disturbed. The larva had somehow worked itself beneath the upper fibers of the paper and made its cocoon beneath. Examination of a cocoon on a leaf showed that the cocoon was beneath the epidermis of the leaf, and that the leaf hairs were in natural position. Later, I was so fortunate as to observe a larva in the act of working in beneath the epidermis, which was done without eating or disturbing the inner structure of the leaf. This separation of the leaf epidermis, or the upper layer of fibers of paper, seems to be accomplished by moistening with an exudation from the mouth, possibly saliva-like, or perhaps of some particular chemical substance adapted to the purpose, and allowing for a loosening of this upper layer as the head of the larva is worked in beneath it. As a further experiment, bits of different colored papers having the color only on the surface were supplied for the larvae to make their cocoons in. In all cases the resulting cocoons were beneath the layer of colored fibers of the surface of the paper. In one instance a cocoon made on a bit of newspaper cut from a black advertisement picture, showed the perfect screen pattern on the top of the cocoon. On opening a cocoon it was found that there is scarcely any real cocoon formed, the cavity merely being lined with a slight layer of silk. The cocoon is bulged upward from the surface of paper or leaf, which causes a parting of the surface material leaving an encircling exposed ring surrounding the cocoon. There is a transverse dorsal ridge towards the anterior end of cocoon.

The pupa is about 4 mm. long, of a reddish brown color; the wing cases extend to the fifth abdominal segment; the segments are crenate at the sides and dorsally as in the larva; apex of abdomen is blunt and without attachment to the cocoon. It is not extruded from the cocoon on the emergence of the moth. The pupal stage is about three weeks.

As the first moth was rather tardy in issuing, being about four weeks, it was suspected that there might be a hibernation period in the cocoon, and perhaps an interval before there would be another brood, conforming to adaptation to more temperature latitude conditions, especially as there seemed a likelihood that the moth might have come from Japan. However, it is now apparent that breeding is continuous and not separated into distinct broods. The present indications are that it is not going to become a pest, for in the places where it is found most abundant the honeysuckle vines have a thrifty appearance, and the mined leaves are not very conspicuous, being mostly hidden by the newest growth of vines.

Of the parasites which have been reared from this leafminer, *Zagrammosoma flavolineata* Crawford occurs in southern California, where it has been reared from the potato tuber moth (Graf, U. S. D. A. Bull.

427:35, 1917). *Notanisomorphomyia externa* Timberlake (Proc. Hawn. Ent. Soc., 6:522, 1927) and *Pseudopheliminus vagans* Timberlake (Bishop Museum Bulletin, 31:37, fig. 5, 1926) are in the family Eulophidae. Both are parasitic in several other lepidopterous leafminers in Hawaii. It would seem that they are native species, but I believe that Mr. Timberlake considered them as immigrant species. I do not know of their occurrence anywhere else.



Swezeyula lonicerae

Figure 3-A.—Cocoon on leaf showing the hairs on the top of the cocoon in natural arrangement as on the leaf surface. This is accomplished by the larva forcing its way beneath the epidermis for the purpose of making its cocoon there.

Figure 3-B.—Cocoon on a bit of newspaper with the print showing undisturbed on top of the cocoon.

Figure 3-C.—Black portion of a newspaper photograph showing how the surface has been raised for making the cocoon beneath without disturbing the screen pattern.

NEW INSECT RECORDS FOR THE YEAR 1949

Species marked with an asterisk were reported in the Hawaiian Islands for the first time in 1949, on the dates recorded in the text. Those not so marked were observed here prior to that year, but have only now been identified or recorded. For particulars refer to the pages indicated.

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